

ELECTRICITY MARKET REFORM:

A means to multiple ends

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EXECUTIVE SUMMARY

The need to reconcile the rules and governance of the 30-year-old European internal electricity market with new public policies, namely the European Green Deal, was recognised long before the energy price crisis of 2021. In fact, this need became apparent in 2009, when the first European “green package” was adopted. And it was explicitly recognised by the European Council in 2011: decarbonisation requires “*a revolution in energy systems*”. However, a combination of institutional inertia, ideology and vested interests has prevented the necessary electricity market reform from getting off the ground.

In 2021 and 2022, the combined gas and electricity price crisis prompted Member States to intervene in these markets by introducing *ad hoc* exceptional rules and massive subsidies to energy suppliers and consumers, amounting to several percentage points of GDP. In addition to reassuring consumers and legitimising some unjustified windfall profits, these interventions had two other consequences: on the one hand, they created huge market distortions; on the other hand, they opened the door to electricity market reform, as the current heavily subsidised and distorted situation is politically unsustainable, and a return to the *status quo ante* is impossible.

In March 2023, the legislative process for the reform of the electricity market was finally launched; however, instead of having only one main, structural objective – to reconcile the old market model with the new green public policies – this reform has a second, conjunctural objective: to avoid that consumers face energy price peaks of the same magnitude again after the current temporary national measures are removed. The concoction of these two objectives, combined with the growing diversity of interests in the energy sector, makes this reform particularly difficult and its outcome uncertain.

In a report published in May 2022, we explained the main reasons for a structural reform of the electricity sector, describing some critical points arising both from the disconnect between the market model and public policies and from inherent or historical failures of the current model. The report then identified some technical trends and assessed their respective contributions to the expected evolution of electricity markets in general. Finally, it proposed a conceptual framework for thinking and talking about structural electricity reform, describing a new multi-sector and multi-level energy architecture that allows for a technically feasible and cost-effective reconciliation of markets and policies.

This report expands on the previous themes, recommending a reform based on 3 principles and proposing a 5-point transition agenda:

Key principles

Subsidiarity	(leading to Europeanisation <i>and</i> decentralisation)
Efficiency	(shaping energy system integration)
Democratisation	(supported by digitalisation, innovation, new actors)

Key reform pathways

1. From commoditisation to communitisation.
2. From a “single market and multiple subsidies” to “multiple markets and no subsidies”.
3. Decentralise the centralised, centralise the decentralised.
4. Deregulate the over-regulated, regulate the under-regulated.
5. Phasing in innovation, phasing out coal and gas electricity generation.

Energy liberalisation – together with the liberalisation of other network industries – was an important step towards a more integrated and efficient European economy and a stronger European polity. Today, electricity market reform is more than a mere technical adjustment: it is an opportunity to put citizens at the centre stage of the energy transition, transforming the internal electricity market from a distant, opaque, algorithm-based centralised machine into a platform of platforms where citizens, communities and municipalities create the most appropriate - competitive and cooperative - mechanisms to manage energy resources according to local needs and aspirations, and work together to implement the European Climate Law: “Each Member State shall establish a multilevel climate and energy dialogue pursuant to national rules, in which local authorities, civil society organisations, business community, investors and other relevant stakeholders and the general public are able actively to engage and discuss the achievement of the Union’s climate-neutrality objective (...) and the different scenarios envisaged for energy and climate policies”.

TABLE OF CONTENTS

Preface	1
0. Introduction	9
 PART I KEY PRINCIPLES	 29
1. Subsidiarity	30
2. Efficiency	33
3. Democratisation	39
 PART II KEY REFORM PATHWAYS	 41
4. From commoditisation to communitisation	42
5. From a “single market and multiple subsidies” to “multiple markets and no subsidies”	45
6. Decentralise the centralised, centralise the decentralised	47
7. Deregulate the over-regulated, regulate the under-regulated	53
8. Phasing in innovation, phasing out coal and gas electricity generation	57
 PART III THE LOCAL PERSPECTIVE	 63
9. Decentralisation and competitive local platforms	64
10. The institutional challenges of energy system integration	71
11. Governance and regulation	76
12. Expected benefits of decentralised systems	79
13. Digital, Distributed, Integrated Energy Systems (DDIES)	82
13.1 Definition	82
13.2 Enabling horizontal multi-sector integration	82
13.3 The local platform	84
13.4 The interface question	87
14. DDIES implementation cases in Europe	96
 PART IV CONNECTING THE DOTS	 103
15. Enabling vertical multi-level integration	104
 PART V HOW TO GET EU ENERGY PRICES UNDER CONTROL?	 109
16. Surplus enjoyment	110
17. Is Spain the new Athens?	128
 PART VI MISCELLANEOUS	 133
18. EU electricity networks or the tragedy of the missing commons	134
19. Cities and electricity	139
20. Revisiting the Internal Electricity Market – identifying reform areas and reformers	144

LIST OF FIGURES

1	Yearly final energy demand EU, 1990-2020	11
2	Structure of final energy demand in European countries, 2019	12
3	Yearly electricity demand EU, 1990-2020	13
4	Monthly electricity demand EU, 2011-2023	13
5	Potential impact of electrification upon EU electricity demand	16
6	Evolution of installed fossil fuel electricity generation capacity by Member State, 1990-2020	18
7	Evolution of total gross electricity generation from fossil fuels EU, 1990-2020	19
8	Main activity producers' net installed electricity generation capacity EU, 1990-2020	20
9	Autoproducers' net installed electricity generation capacity EU, 1990-2020	20
10	Gross generation and installed generation capacity EU, 2005-2021	21
11	Evolution of renewable electricity generation capacity and CO2 price EU, 2008-2021	23
12	Evolution of gross electricity generation by source EU, 1990-2020	23
13	Evolution of gross electricity generation (fossil vs. wind&solar) EU, 1990-2020	24
14	Offshore wind electricity generation capacity in selected European countries, 2011-2021	24
15	Stylized description of efficiency impact upon electricity generation and demand	35
16	Wholesale electricity prices in several countries compared to Germany	42
17	Evolution of gross electricity generation (decarbonisation) EU, 1990-2030	58
18	Evolution of gross electricity generation (decarbonisation and electrification) EU, 1990-2030	59
19	Charging points deployment versus sales of electrically-chargeable cars in the EU	65
20	Yearly sales of new cars in the EU by fuel type, 2018-2021	66
21	Yearly sales of residential battery energy storage systems in Europe, 2013-2021	66
22	Yearly sales of heat pumps in Europe, 1990-2021	67
23	Different energy management platforms at local level	68
24	Local energy platform – basic design process	72
25	The old electricity distribution network in context	73
26	The new local electricity platform in context	73
27	Digital, Distributed, Integrated Energy Systems (DDIES)	84
28	The 3 layers of DDIES	87
29	Identifying DDIES interfaces	89

30	DDIES interfaces in context	89
31	Smart meter penetration in Europe	92
32	Flexibility pilot projects in Sweden	98
33	EU electricity structure – past	106
34	EU electricity structure – future	107
35	Simplified wholesale electricity market - price mechanism	116
36	Simplified wholesale electricity market – inframarginal rents	117
37	Simplified wholesale electricity market – guaranteed price	118
38	Simplified wholesale electricity market – windfall profits	119
39	International coal prices, 2019-2023	120
40	Corporate clean power purchase agreement volumes by region, 2010-2021	122
41	Total yearly contracted new PPA capacities in Europe	123
42	Phasing-out fossil electricity generation	127

LIST OF TABLES

1	EU final energy demand in 2020 by energy product and by use sector	14
2	Total installed electricity generation capacity EU, 2020	21
3	Allocation of key energy system functions to different decision-making levels	32
4	Advantages of polycentric systems in coping with design and long-term sustainability of systems	76
5	Assessment matrix for local energy platforms	96

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PREFACE

The President of the European Commission announced in the European Parliament, on 7 June 2022, that “this [electricity] market system does not work anymore. We have to reform it”, and on 14 September 2022, following the call of the European Council, she went to say that this meant “[n]ot just a quick fix, but a change of paradigm, a leap into the future.”

Her bold statements were received with surprise and scepticism by many groups and experts who have become accustomed to seeing the European Internal Electricity Market as an end in itself, a depoliticised, technocratic trading platform, ignoring both the political impulses that led to its construction since the late 1980s, and the impact of new public policies, as well as technical and societal developments, that cannot be assimilated to ordinary “market externalities”.

When the European Commission presented its “Proposal for an amending Regulation to improve the Union’s electricity market design”, on 14 March 2023, sceptics saw electricity market reform as an exercise in fine-tuning the past, rather than “a leap into the future”.

Although electricity market reform will inevitably be an incremental process, due to inherent technical complexity, investment cycles and conflicting Member State views, necessity should not be confused with virtue, nor progressive realism with unreceptive obstinacy. In other words, the European electricity market is not an end in itself, but a means to an end. **Therefore, electricity market reform should be about adaptation and evolution, not about preservation and perpetuation.**

Energy markets were introduced in Europe in the 1990s mainly to increase economic efficiency and thus improve competitiveness of European industry after a long period of “eurosclerosis”. This objective remains valid, but nowadays it must be compounded with two additional major objectives:

- facilitating the transition to EU carbon neutrality and
- enhancing EU security.

This implies, on the one hand, phasing out natural gas use and natural gas markets and, on the other hand, boosting and reshaping electricity markets. Moreover, the recent energy price crisis has highlighted the importance of:

- adequate protection of energy consumers under abnormal conditions, and
- appropriate inclusion of energy in the broader EU political economy, namely as regards industrial, social and external policies.

Electricity market reform is about transforming the Internal Electricity Market into an effective means of accomplish multiple ends.

II

“Market democracy tends to see resources in context-dependent ways. (...) Cultures with easy access to sperm whales were once considered to be richer in natural resources than those with petroleum (or uranium) deposits.”

John Tomasi ¹

Markets in general, and electricity markets in particular, are not engendered by nature or revealed by God - they are social constructions that serve a particular purpose in a particular historical context. Consider Nasdaq: it was created in 1971 at the request of the US regulator (Securities and Exchange Commission) to solve a specific problem (improving the trading of US securities not listed on existing exchanges) through a new computerised trading system. Its innovative model and lower listing fees initially attracted new high-tech companies, but Nasdaq soon expanded its scope to become a global platform for trading of stocks, derivatives, fixed income and commodities. Today, it is the world's second largest stock exchange operator by market capitalisation of listed companies (about three times larger than Euronext)².

Like Nasdaq, most organised markets have been created at the request of public authorities rather than spontaneously; like Nasdaq, many successful organised markets have invented new products and new processes, transforming themselves over time, either to meet new needs or to explore new technical possibilities. The European Internal Energy Market is no exception: it was created by the European legislator almost 30 years ago (in the face of strong opposition from the energy industry and scepticism from consumer groups) and now needs to be transformed to support, i.e., the EU's transition to carbon neutrality and the EU's strategic autonomy. For whatever reason, market agents and market operators have not been able to design and enforce the necessary transformation themselves, thus making the ongoing EU legislative intervention inevitable. In the 1970s, computers “created” Nasdaq and revolutionised financial markets; today, energy digitalisation enables the development of digital platforms that are already transforming energy markets.

Given the complexity of energy markets, the convoluted nature of EU decision-making and the current political and economic context, the risk of a belated, cross-bred electricity reform should not be underestimated.

The main purpose of this report is to identify some of the major risks that threaten a consistent EU electricity reform and to suggest ways to avoid them, thus contributing to a more coherent outcome. The method used consists in bringing to the foreground a combination of frequently ignored (or repressed) basic questions and frequently overlooked data.

¹ John Tomasi, *Free market fairness*, Princeton University Press, 2012. Pg. 111.

² <https://www.statista.com/statistics/270126/largest-stock-exchange-operators-by-market-capitalization-of-listed-companies/>

*

Economics, like any other science, is subject to evolution. Our understanding of markets in 2023 is different from that of 1993, or 1923, or 1823... Both economic theory and implementing market tools (such as computers) have changed over time - and keep changing. Therefore, there is no such thing as ‘the’ market - an immutable, universal set of rules that unequivocally define ‘the’ market³. The conceptual toolkit of economics and political economy is much richer in 2023 than it was in the late 1980s/early 1990s, when European energy markets were first designed; electricity market reform could – and should – benefit from these scientific developments, as well as from other scientific and technical advances⁴.

Before embarking on any market design (or redesign) exercise, it is important to understand both the context (public policies, technical developments, social and political organisation, available natural resources, etc.) in which the market is supposed to operate and deliver, and the conceptual and instrumental tools available. The latter depends on objective technical and scientific progress (see previous paragraph), while the former requires a blend of objective and subjective assessments, as shown below and further developed in subsequent chapters.

As the opening quote above states, “[m]arket democracy tends to see resources in context-dependent ways”. When the 6-member European Economic Community was established in 1958, coal accounted for 70% of its gross energy demand; by the end of the 20th century, in the 15-member European Community, this ratio was only 15%. In 1958, nuclear and natural gas were absent from the European electricity generation mix; today they each account for about 22%. When the European electricity and natural gas markets were first designed, in the 1990s, both oil and natural gas prices were relatively low and stable; in the 21st century, they have been high and volatile. Moreover, the EU has decided to reach carbon neutrality by 2050, getting rid of all fossil fuels (coal, oil and natural gas), and has ambitious targets for 2030⁵.

Future electricity markets, in 2030 and beyond, will be based on completely different energy sources and resources (including new storage and control devices), not only in Europe⁶. This will require a very different electricity market from the one we have today; the evolution cannot and will not happen overnight, but it will happen – in fact, it is already happening on the ground, if not yet at the institutional level. The sooner the legal and institutional framework is adapted to the new energy context, the faster and more cost-effective this energy transition will be.

3 “Smith’s and Hegel’s accounts of the market as historically embedded thus present us with good reasons for thinking that a timeless, ahistorical theory of ‘the market’ will never be possible” - L. Herzog, *Inventing the market*, Oxford University Press, 2013. Pg. 157.

4 For a refreshing critical assessment of the economics of climate change see Simon Sharpe, *Five times faster. Rethinking the science, economics, and diplomacy of climate change*. Cambridge University Press, 2023, Part II.

5 55% reduction of EU greenhouse gas emissions by 2030, compared to 1990, translates into about 65% of EU electricity generation from renewable sources by 2030. Some governments announced even higher renewable electricity ambitions for 2030: for example, Denmark plans to reach 100% and Germany 80% (100% by 2035).

6 According to the United Nations, “Cheap electricity from renewable sources could provide 65 percent of the world’s total electricity supply by 2030. It could decarbonize 90 percent of the power sector by 2050, massively cutting carbon emissions and helping to mitigate climate change.” <https://www.un.org/en/climatechange/raising-ambition/renewable-energy>

Lighting is one of the most basic and oldest forms of energy use, and its history offers interesting insights into the current debate on electricity reform. For many centuries, oil lamps were used as source of light. While in Mesopotamia olive oil and other vegetable oils were used, in other areas animal fat or fish and sperm whale oil were used instead. This is why sperm whale was considered a strategic natural resource, as the quote above suggests. Sperm whaling became an important economic activity in the 17th century and continued until the late 19th century, when petroleum products replaced sperm whale oil. Apart from its use as lamp oil, sperm whale oil had many other uses, such as the manufacture of candles, soap, cosmetics, lubricants, pharmaceutical products, etc..

In the Middle Ages, when they were diffused, candles were first made from tallow, then from vegetable and animal waxes (including sperm whale), and finally from paraffin (a wax derived from petroleum). They were more convenient than oil lamps, but more expensive. In the 19th century, kerosene lamps replaced both oil lamps and candles and they are still widely used in rural areas of Africa and Asia^{7 8}. Later, in 1880, the following statement was attributed to Edison by a journalist and reprinted in several newspapers: “After the electric light goes into general use none but the extravagant will burn tallow candles”⁹.

In short, to satisfy a given social need, such as lighting, different natural resources have been and can be used, depending on the availability of both resources and the technical means to convert them; many natural resources used as energy products are also raw materials for other industries, thus creating potential economic and social tensions, as illustrated below.

Since gas and electricity prices exploded, in late 2021, governments across Europe have intervened to control energy prices. This is what governments have always done, in similar circumstances, at least since the Middle Ages. In 1348, for example, when the black plague hit Florence, the price of candles exploded. In the words of one chronicler, «[t]he wax was a miracle» and so expensive that the government intervened by forbidding «the wearing of more than two doubles» in order to put «a brake on the great excesses»¹⁰. In 1389, a new plague and the consequent ban on the importation of animals from contaminated places led to a shortage of candles in Milan:

“The blockade of the influx led to a shortage of meat, but also of tallow. From January, the signs of the famine could be read in the decrees: first of all, the candlemakers had to stop selling tallow to the leather tanners until Easter, an indication of the scarcity of the raw material, but also of the commercial relations between the two

7 In 2005 it was estimated that “fuel-based lighting is responsible for annual consumption of 77 billion liters of fuel worldwide” – Evan Mills, *The specter of fuel-based lighting*, Science, Vol 308, Issue 5726, 27 May 2005. <https://www.science.org/doi/10.1126/science.1113090>

8 While discussing electricity market reform in Europe one should not forget that more than 700 million people do not have yet access to electricity, most of them living in Africa – in spite of the collective engagement to “Ensure access to affordable, reliable, sustainable and modern energy for all” (sustainable development goal nr. 7). At the present rate, 679 million people will still be deprived of access to electricity by 2030 – <https://sdgs.un.org/goals/goal7>.

9 <https://quoteinvestigator.com/2012/04/10/rich-burn-candles/>
Another version widely attributed to Edison is: “We will make electricity so cheap that only the rich will burn candles.”

10 Quoted in Beatrice del Bo, *L'età del lume. Una storia della luce nel Medioevo*, il Mulino, Bologna, 2023. Pg.89.

categories and of how much cheaper the trade in fat must have been than using it to make candles. In the same juncture, the requests of the candlemakers focused precisely on the selling price, so much so that they obtained the concession of an increase (from 3 soldi to 3 soldi and 2 denari of Milanese imperials per pound), subject, however, to the assurance demanded by the authorities that the city would be abundantly supplied with candles. The government also asked them to limit sales to private individuals to 2 pounds, a quantity apparently deemed sufficient for family needs.”¹¹

This episode reveals a stable (very *longue durée*...) pattern of bargaining between energy suppliers and public authorities, especially in crisis situations, and of trade-offs between security of energy supply, energy prices and wider macro-economic impacts. What is astonishing about 2022 interventions in the form of rationing, price controls, etc., is not that they happened, but that they reproduce the same patterns observed almost seven hundred years ago, and are no more effective in terms of preventing scarcity, opportunistic price hikes and absurd windfall profits:

<< The subsidies in most countries disproportionately benefited the wealthy, who consume more, a senior commission official said. “The measures were not very well targeted and did little to reduce consumption.” >>¹²

Hopefully, the energy price crisis will soon be over, and efforts will focus on the much-needed structural reform of the electricity market in the new energy context of 2030/2050, under the motto “we will make decarbonised electricity so cheap that only the rich will burn fossil fuels”. However, as explained in this report, **energy decarbonisation can only be achieved through systemic energy digitalisation and sophisticated local digital energy platforms - integrating demand, storage and generation resources across all energy-related sectors, and enabling exchanges between all platforms embedded in a revamped Internal Electricity Market.**

*

The Internal Market project, launched in 1987 and due to be completed by December 1992, was a *political* project based on the *depoliticisation* of key economic sectors, including energy. The rationale was that the liberalisation and supranational integration of these sectors would improve European economic competitiveness (notably through economies of scale) and thus reinforce European political clout. Moving negotiations from the realm of policy and politics to the market sphere, replacing the highly charged language of power (sovereignty, reciprocity, security, etc.) with the cold language of economics (efficiency), was a means of achieving this political goal. For the authors of the Single European Act, this method would lead to a new polity at the end of the road.

This was a risky project from the outset. The lack of specialised European institutions to supervise and regulate European markets had negative consequences for both market efficiency and the democratic legitimacy of the whole process. The longer the construction of the Internal Market took, the greater the risk of repoliticising the ongoing

11 Ibid, pg. 93 (own translation).

12 Quoted in Financial Times, *EU countries urged to phase out huge energy subsidies*, March 8, 2023.

Europeanisation of economic sectors. In 2000, two simultaneous decisions exacerbated this risk: on the one hand, the political ambition and the expected delivery of the Internal Market were significantly increased (the so-called “Lisbon Agenda 2010”), out of proportion to the available institutional resources; on the other hand, the chances of institutional Europeanisation to support an increasingly complex and ambitious Internal Market were reduced through the increased adoption of the intergovernmental method. Subsequently, the Lisbon Treaty (2007) failed to address these risks.

The financial crisis of 2007/2008 and the successive sovereign debt crisis exposed the weaknesses of European financial markets and monetary governance, leading to massive political (intergovernmental) interventions and a patchwork of *ad hoc* institutional remedies. The energy crisis of 2021 revealed the inherent weakness of the Internal Energy (electricity and natural gas) Market. So far, the response has been massive political (national) intervention through huge subsidies and new *ad hoc* rules, de facto shelving competition and other “common rules”. The repoliticisation of electricity and gas is here to stay; a return to the old, depoliticised electricity market approach is implausible.

The current debate on electricity market reform must be seen in this political context. What is at stake is not a choice between alternative technical fixes - it is a choice between two very different political positions: continuing to dismantle the Internal Energy Market, satisfying disparate national political requests while maintaining the appearance of depoliticisation and continuity under the current market model; or gradually replacing the current market model with a more articulated and politicised energy architecture, aligned with EU climate and energy policies, and thus redefining and strengthening the Internal Energy Market. Unfortunately, the former has the highest probability of success; nevertheless, this report makes the case for and proposes the latter in the belief that it will better serve Europe now and in the future.

III

“Since everything then is cause and effect, dependent and supporting, mediate and immediate, and all is held together by a natural though imperceptible chain, which binds together things most distant and most different, I hold it equally impossible to know the parts without knowing the whole, and to know the whole without knowing the parts in detail.”

Pascal¹³

Our desire to know the whole and the parts at the same time, i.e., to know how to enforce “coordinated planning and operation of the energy system ‘as a whole’ ”¹⁴, reorganising the Internal Electricity Market as a “platform of platforms”, and how to organise each new platform, local or offshore, echoes Pascal’s above-mentioned statement. While this aspiration is logical, its accomplishment is challenging.

We know how the Single Market works today, but we also know that its functioning needs to be adapted to new technical and public policy conditions. We know that decentralisation is happening, in many places and in different forms, but we also know that there is no such thing as a regular pattern of local platforms. We know that all these platforms are “cause and effect, dependent and supporting”, but we don’t yet know in detail how to hold them together.

Pascal also warns us against the illusion that *little things* (e.g., local platforms) are easier to be grasped: “We naturally believe ourselves far more capable of reaching the centre of things than of embracing their circumference. The visible extent of the world visibly exceeds us; but as we exceed little things, we think ourselves more capable of knowing them. And yet we need no less capacity for attaining the Nothing than the All.”¹⁵ Indeed, as digital power continues to grow, in a few years local platforms will reach levels of complexity and sophistication that far exceed the current performance of the Single Market, just as smart mobile phones far exceed the performance of earlier mainframe computers.

These philosophical considerations prepare us to live, at least for some time, without complete knowledge of the whole and the parts of future electricity systems. But that should not prevent us from starting to build new energy architectures now: there are several certitudes and the number of known unknowns is limited. With so many people around the world working hard to fill these gaps, new, dynamic architectures will evolve rapidly and converge rapidly towards increasing levels of efficiency and freedom¹⁶.

13 Blaise Pascal, *Pascal’s Pensées*, E.P. Dutton&Co., Inc., New York, 1958. Pg. 20. <https://www.gutenberg.org/files/18269/18269-h/18269-h.htm>

14 European Commission, *Powering a climate-neutral economy: An EU Strategy for Energy System Integration*, COM(2020) 299 of 08.07.2020.

15 Ibid., pg. 19.

16 Present electricity systems offer limited freedom and impose many restrictions upon network users – for the sake of “keeping the lights on”. Moreover, the EU imposed a single market model – for the sake of “welfare maximisation”. Digitalisation will enable users to invent new ways of combining energy resources, energy uses and energy users, exercising their freedom without putting at risk the physical integrity and the institutional unity of the European electricity system.

The periodic table of the chemical elements was introduced by Dimitri Mendeleev (1834-1907) in 1869, when many entries were still missing. As we now know, the layout of the periodic table depends on the structure of the atoms associated with each element, namely the way in which three subatomic particles (protons, electrons and neutrons) are organised within the atom. It is remarkable that Mendeleev produced his periodic table 27 years before the first subatomic particle, the electron, was discovered, by Joseph Thomson (1856-1940), in 1897. It is also noteworthy that Mendeleev rejected the idea of subatomic particles and believed, even after 1897, that atoms were indivisible¹⁷...

Since 1869, the structure of the periodic table has undergone several adjustments, both as a result of new elements being discovered in nature or synthesised in the laboratory, and as a result of new discoveries about the nature of atoms.

As far as the EU electricity reform is concerned, we are now in a situation similar to that of the chemists in 1869: we have before us a well-organised structure (i.e., a multi-sector and multi-level energy architecture), but we know that this structure will be adjusted and enhanced step by step; most of the building blocks are known, but a few critical entries are still missing (e.g., efficient, cost-effective, long-term storage). Ignoring the electron did not prevent Mendeleev from designing the “right” periodic table; similarly, ignoring many “things to come” should not prevent us from designing and implementing the “right” energy architecture for decarbonisation through energy system integration now. Mendeleev’s periodic table was more than just a descriptive taxonomy of known entities – it was a kind of work programme that incentivised and guided the search for new elements. Similarly, the new multi-sector and multi-level architecture proposed in this report is a call to action, a broad conceptual framework that enables innovative solutions to develop in parallel and to fit together into a new structure, fit for 55 and beyond.

17 John Emsley, *Nature’s building blocks*, Oxford University Press, 2001. Pg. 511 ff.

0. INTRODUCTION

“[many problems] persist in spite of the analytical ability and technical brilliance that have been directed toward eradicating them. No one deliberately creates those problems, no one wants them to persist, but they persist nonetheless. That is because they are intrinsically systems problems – undesirable behaviors characteristic of the system structures that produce them. They will yield only as we reclaim our intuition, stop casting blame, see the system as the source of its own problems, and find the courage and wisdom to restructure it. Obvious. Yet subversive. (...) Comforting, in that the solutions are in our hands. Disturbing, because we must do things, or at least see things and think about things, in a different way.”

Donella H. Meadows¹⁸

A conversation about EU electricity market reform should start with a quantitative analysis of electricity demand, taking into account its current structure and assessing how decarbonisation through electrification will impact electricity demand. This quantitative assessment can then be used to simultaneously discuss a) how electricity generation will evolve to deliver the required amount of green electricity, and b) how electricity networks will need to evolve to accommodate new demand and generation profiles. This discussion must take into account the essential large-scale deployment of new asset classes, such as electrical and thermal storage (to some extent alternatives to generation and network investment), the conundrum of energy system integration and the inevitable impact of energy digitalisation, price signals and subsidies, as well as changes in societal expectations and consumer behaviour.

Once this appraisal is accomplished, four main questions can be orderly addressed:

- a)** What kind of market model can drive the transition to a fully decarbonised electricity system?
- b)** What type of market model is better suited to the functioning of a fully decarbonised electricity system?
- c)** How can the current EU market model be reformed to facilitate the transition to a fully decarbonised electricity system, as envisaged in a) above ?
- d)** What actions need to be taken and what goods need to be produced that markets cannot realistically deliver, and therefore require some kind of political or regulatory intervention?

Answering these questions helps to define a coherent course of action and a consistent energy transition.

The real world is indeed not as simple and sequential as assumed in the first paragraph: demand patterns have already been changing for some time, generation patterns have already changed substantially in many countries, different types of storage have been deployed in conjunction with generation or demand resources, or even as a

18 Donella H. Meadows, *Thinking in Systems*, edited by Diana Wright, Chelsea Green Publishing, Vermont, 2008. Pg. 4.

stand-alone network resource. These ongoing changes have indeed exposed the difficulties of current market, operational and institutional models to accommodate them and have created significant pressure for electricity market reform, even before the energy price crisis emerged in 2021.

The scale and pace required for a successful energy transition towards 2030 and 2050 is not compatible with implementing a series of timid, incremental amendments to the current market and institutional models, as has been the case in recent years. Moreover, such *ad hoc* changes, which bow to the pressure of new inexorable realities (e.g., the reversal of electricity flows in some distribution networks due to the massive deployment of solar rooftops in the areas they serve) and overlook the challenges of energy system integration, do not guarantee a coherent and smooth transition – on the contrary, the risk of delays and wrong investment decisions is high. Therefore, a more systemic approach is needed, which does not ignore short-term urgencies and current boundary conditions, but looks beyond them.

A common objection to a comprehensive reform of the electricity market is that, since nobody knows yet which technical solutions for full energy decarbonisation will prevail, the current market model should not be changed for the time being. This argument usually leads to one of two positions: quietists preach absolute passivity and contemplation; others, for the sake of keeping all things in common, like Barallots, advocate minimalist “targeted reforms”.

While it is true that there are a few “known unknowns” regarding energy decarbonisation and the future of electricity systems, namely regarding seasonal energy storage, it is also true that, as per today, the many “known knowns” enable conceptualisation and implementation of cost-efficient technical solutions that could lead to a very high percentage of energy decarbonisation in the near future. Some authors believe that “95 percent of the technologies needed for a transition to 100 percent WWS [water, wind and sun] are currently commercialized”¹⁹, enabling 100% or at least 80% decarbonisation by 2030; other authors suggest slightly different percentages and timelines, but the main point is that it is technically and economically feasible to achieve a very high percentage of decarbonisation, very soon, applying existing technical solutions. Under these circumstances, no reasonable interpretation of the precautionary principle can justify the choice of procrastination over action: what can be achieved under a “no-regret policy” is much more than what cannot.

Besides inaction and piecemeal action, another trendy attitude should be avoided: the “all-of-the-above” approach²⁰. This approach usually reveals one of two attitudes: in the most benign case, a naïve belief that by encouraging investment in all available technical solutions policymakers will minimise the risk of path dependency and stranded investments; otherwise, sheer opportunism by promoters of the most expensive solutions. It assumes that available clean technical solutions are roughly equivalent

19 Mark Z. Jacobson, *No miracles needed*, Cambridge University Press, 2023. Pg. 327.
(See also R. Villamizar, R. Willoughby and V. López-Ibor Mayor, *Energy and power futures*, Global Square Editorial, Madrid, 2020.)

20 Ibid, pg. 328.

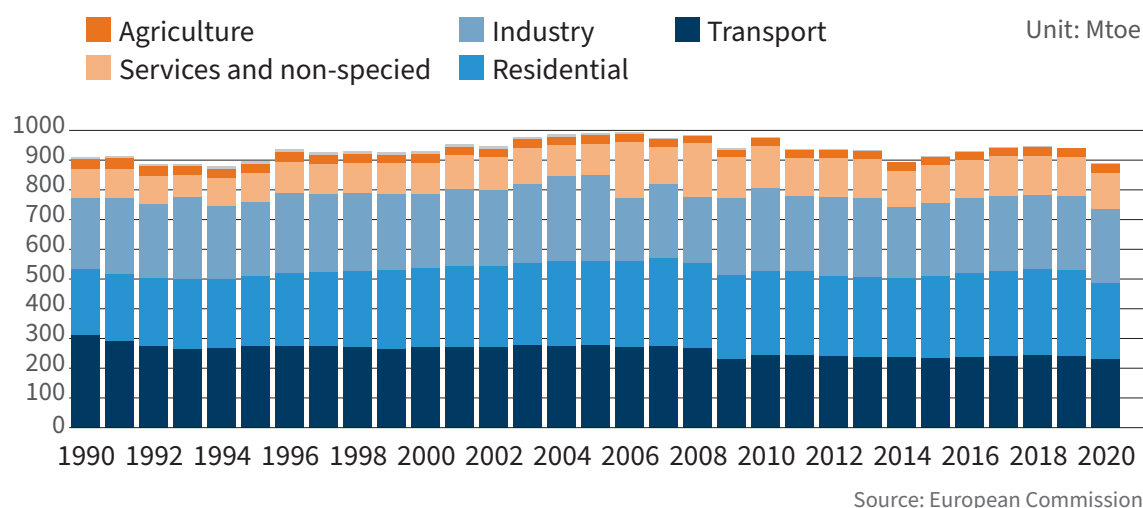
in terms of cost and environmental performance, which is simply not true²¹. A serious public policy - national or local - should exploit the most cost-efficient technical solutions first, leaving the more expensive and/or less efficient solutions only to address the remaining problems: what can be achieved under a “no-regret policy” should be planned and implemented now.

Even if no Member State adopts the “all-of-the-above” approach, such a situation may arise to some extent at EU level, since Member States have the “right to determine the conditions for exploiting its energy resources, its choice between different energy sources and the general structure of its energy supply” (Article 194 TFEU). For this reason, some experts believe that “[f]or the EU, expediting green energy is unlikely to be unifying”, given that “the EU’s authority in energy policy is weak”²². However, if properly framed, this diversity can be effectively managed, while respecting the integrity and coherence of the Internal Energy Market and the freedom of Member States and local communities. Diversity resulting from different decentralised options can and should be accommodated at European level; it is a very different process from implementing a centralised “all-of-the-above” strategy.

Energy and electricity demand

The volume of total final energy demand in the EU-27 has not changed significantly, over the last 30 years, as can be seen in the next figure²³: essentially, a 25% decrease in industry demand was offset by demand increases in transport (14%) and services (27%), total yearly demand remaining stable at around 900 Mtoe (equivalent to 37.683 EJ or 10 467 TWh).

Figure 1 | Yearly final energy demand EU, 1990-2020



21 As the lyrics of a famous bossa nova hit (*One note samba*, by Tom Jobim, 1962) teaches:

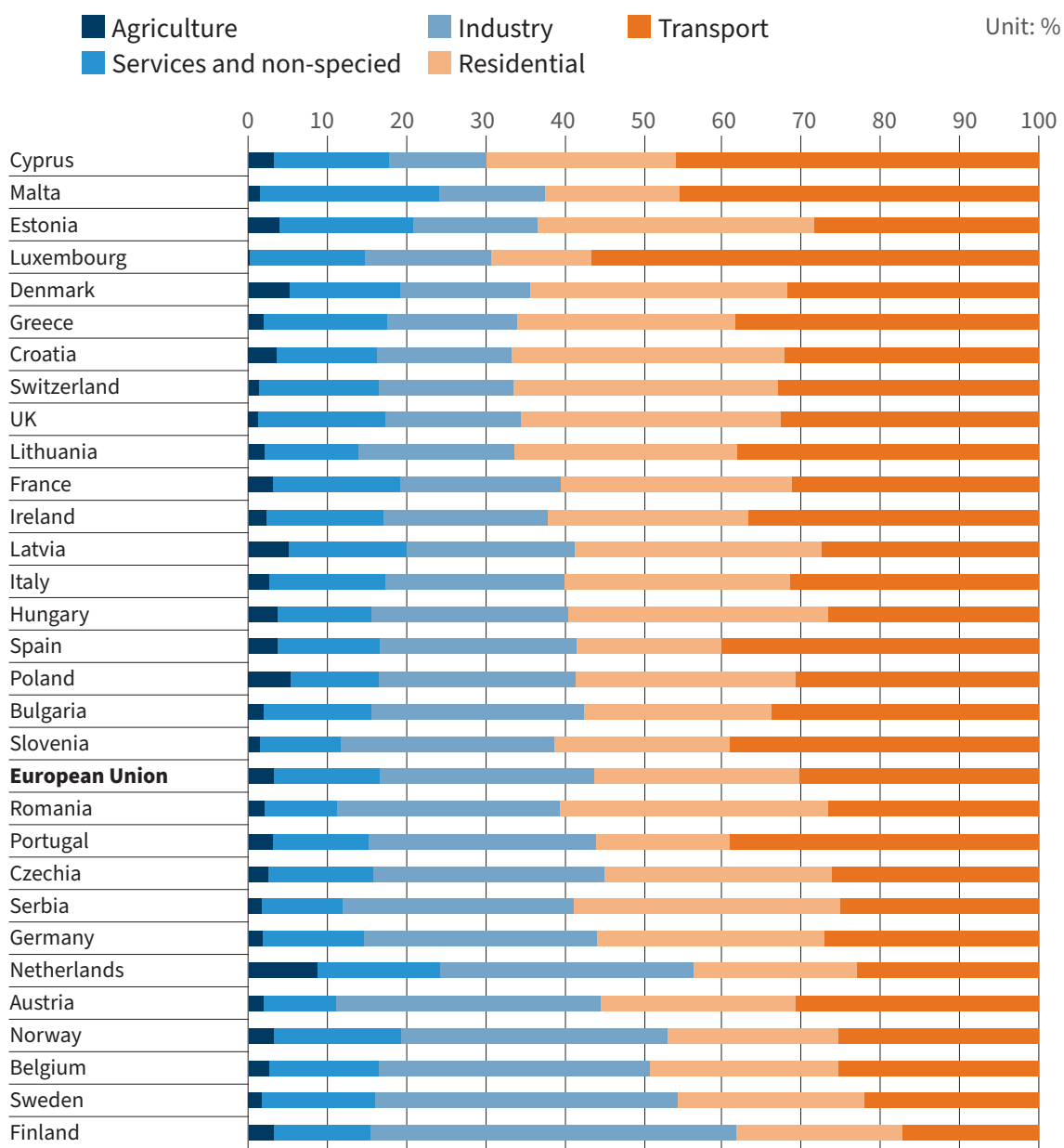
“Anyone who wants the whole show
Re mi fa sol la si do
He will find himself with no show”

22 See Helen Thompson, *Disorder. Hard times in the 21st century*, Oxford University Press, 2022. Pg. 275.

23 Own elaboration based on European Commission, *Energy datasheets: EU countries*, update 29 April 2022.

Structural differences between European countries can be observed in the next figure²⁴.

Figure 2 | Structure of final energy demand in European countries, 2019

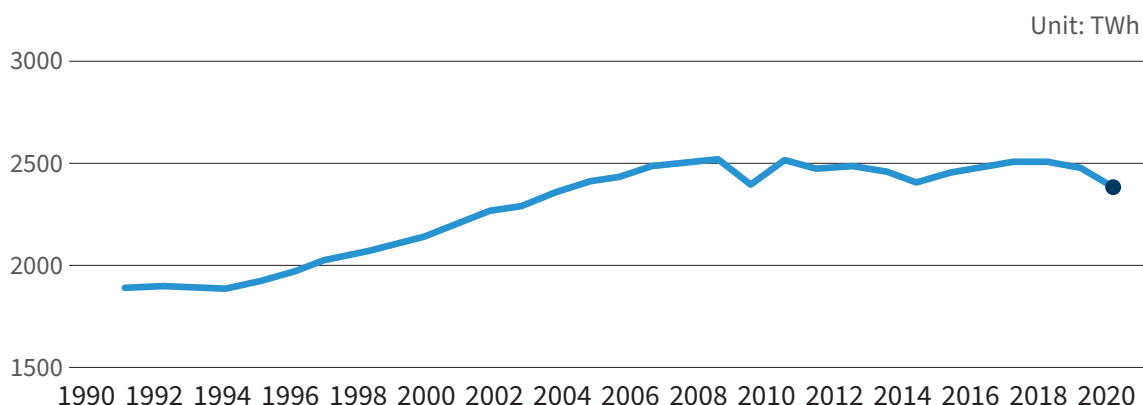


Source: European Commission

Electricity demand increased until around 2005 and has been stable since then, at around 2 500 TWh per year, as can be seen in the next figure²⁵ (in 2021, electricity demand is back to the level of 2019).

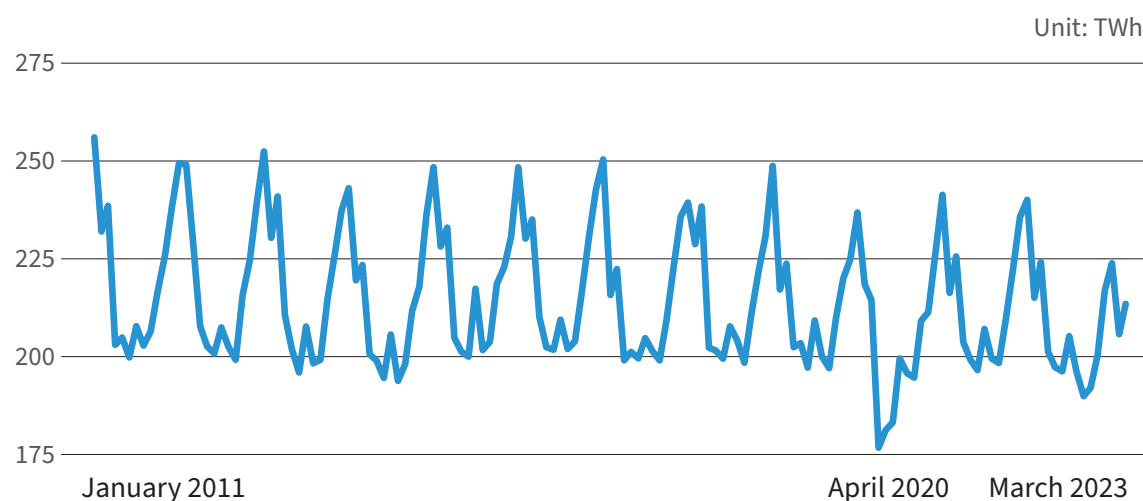
²⁴ <https://www.odyssee-mure.eu/publications/efficiency-by-sector/overview/final-energy-consumption-by-sector.html>

²⁵ Own elaboration based on European Commission, *Energy datasheets: EU countries*, update 29 April 2022.

Figure 3 | **Yearly electricity demand EU, 1990-2020**

Source: European Commission

Monthly EU electricity demand patterns have also been stable in recent years, maintaining their respective seasonal variations, as shown in the following figure²⁶ for the period January 2011- March 2023: the winter peak is around 250 GWh and the summer low is around 200 GWh (except in 2020 due to COVID-19, when the low was reached in April).

Figure 4 | **Monthly electricity demand EU, 2011-2023**

Source: Eurostat

The following table describes the EU final energy demand (Mtoe) in 2020, disaggregated first by energy product and then by energy use (sector)²⁷. As can be seen from this table, in 2020 electricity accounts for only 23% of the total final energy demand (205.06 Mtoe

²⁶ Own elaboration based on Eurostat, https://ec.europa.eu/eurostat/databrowser/view/NRG_CB_EM__custom_6583259/default/line?lang=en

²⁷ European Commission, *Energy statistical country datasheets* (update 17.08.2022). Percentage figures added by the author.

out of 885.76 Mtoe); the largest share (35%) corresponds to oil and petroleum products, which are mainly used in the transport sector, which accounts for 28% of the total final energy demand; road transport accounts for most of transport energy demand.

Buildings (residential and services sectors) are the largest energy “users”, with a combined share of 42% of total final energy demand²⁸. Industry comes third (after transport), with a share of 26%.

In households, 79% of final energy is used for heating (space 64% and water 15%)²⁹. In services, heating and cooling also exhibit the highest final energy share.

Table 1 | EU final energy demand in 2020 by energy product and by use sector

Unit: Mtoe

Final energy consumption	885,76	
by Fuel/Product		
Solid fossil fuels	18,96	2%
of which hard coal	13,27	1%
of which brown coal	1,43	0%
Manufactured gases	3,89	0%
Peat and peat products	0,38	0%
Oil shale and oil sands	0,00	0%
Oil and petroleum products	310,31	35%
Natural gas	193,93	22%
Renewables and biofuels	104,25	12%
Solar thermal	2,44	0%
Geothermal	0,56	0%
Solid biofuels and renewable w	68,88	8%
Biogases	2,73	0%
Liquid biofuels	16,87	2%
Ambient heat (from heat pump	12,77	1%
Waste, non-renewable	4,99	1%
Electricity	205,06	23%
Heat	43,99	5%
by Sector		
Industry	231,21	26%
Transport	251,97	28%
Rail	4,72	1%
Road	238,22	27%
Domestic aviation	3,08	0%
Domestic navigation	3,65	0%
Pipeline transport	1,50	0%
Other transport	0,81	0%
Residential	248,24	28%
Services	121,38	14%
Agriculture and Fishing	29,34	3%
Others	3,63	0%

Source: European Commission

28 Worldwide, “In 2021 the operation of buildings accounted for 30% of global final energy consumption and 27% of total energy sector emissions (8% being direct emissions in buildings and 19% indirect emissions from the production of electricity and heat used in buildings).” IEA, 2022 <https://www.iea.org/reports/buildings>

29 Eurostat, *Disaggregated final energy consumption in households – quantities*, NRG_D_HHQ



As a result of EU and national energy and climate public policies, the decarbonisation of mobility and heating/cooling has started several years ago, and the deployment rates of electric vehicles, heat pumps and residential battery energy storage systems have increased significantly, even before the 2021/2022 energy price crisis: in 2021, sales of heat pumps, electrically chargeable cars and residential batteries increased respectively by 34 %³⁰, 67%³¹ and 107 % compared to the previous year³². These trends will continue due to recently adopted public policies aimed at accelerating energy decarbonisation and strategic autonomy.

If only half of the energy demand for road transport (119.11 Mtoe) and industry (115.61 Mtoe) were electrified, electricity demand would increase by 234.72 Mtoe, from 205.06 Mtoe up to 439.78 Mtoe – i.e., an increase of 114 %. In this case, electricity would account for 50 % of total final energy demand.

This is an approximation because:

- Electric vehicles are more efficient than comparable internal combustion engine vehicles - “EVs convert over 77% of the electrical energy from the grid to power at the wheels. Conventional gasoline vehicles only convert about 12%–30% of the energy stored in gasoline to power at the wheels”³³; and
- Heat pumps are much more efficient than fossil fuel heating systems – the efficiency of a modern gas boiler is around 90%, while air source and ground heat pumps efficiency is around 300% and 400%, respectively.

Therefore, assuming invariant final energy use, electrification leads to lower final energy demand, as illustrated by the following well-known lighting example where LED replaces incandescent bulb (figures are approximate and depend on manufacturer and product; they are all expressed per unit of time):

FINAL ENERGY DEMAND (ELECTRICITY)	60 W	6 W
		
ENERGY LOSSES (HEAT)	~54 W	~0.6 W
USEFUL ENERGY (LIGHT)	800 lm	

30 EHPA, <https://www.ehpa.org/market-data/>

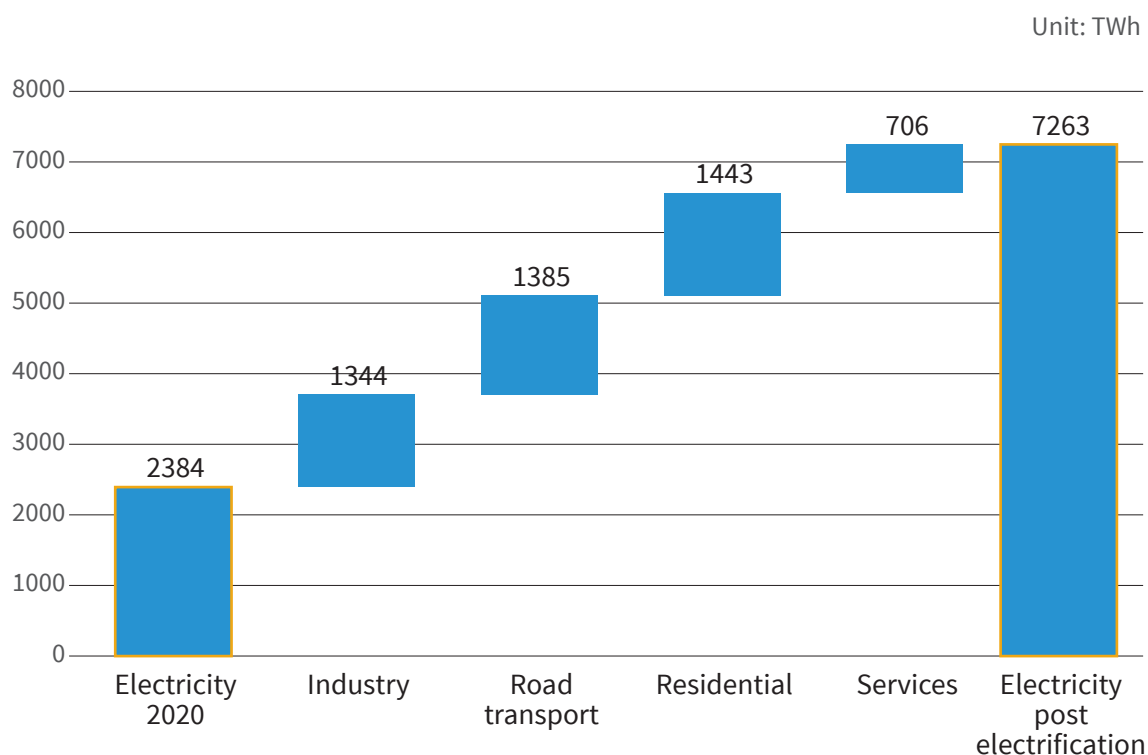
31 ACEA, *The automobile industry. Pocket book 2022/2023*. https://www.acea.auto/files/ACEA_Pocket_Guide_2022-2023.pdf

32 Solar Power Europe, *European Market Outlook For Residential Battery Storage 2022–2026*, December 2022. <https://www.solarpowereurope.org/insights/thematic-reports/european-market-outlook-for-residential-battery-storage-1>

33 US DOE <https://www.fueleconomy.gov/feg/evtech.shtml>

If half of the residential energy demand and half of the services energy demand (mainly heating and cooling) are also electrified, together amounting to 184.81 Mtoe, the share of electricity in final energy demand will increase to 71%, representing a 205 % increase of electricity demand compared to 2020 levels. The next figure shows this electrification scenario in TWh.

Figure 5 | **Potential impact of electrification upon EU electricity demand**



Source: Own elaboration based on Eurostat

The above figure is indeed a very rough estimate of the potential impact of decarbonisation through electrification on electricity demand. However, it is certain that the current and expected trends described in the previous paragraphs imply a deep structural change in electricity demand: not only will its volume experience a considerable expansion, but also the required network connection capacities will have to increase over-proportionately. This is due to the fact that both heat pumps and fast charging stations for electric vehicles exhibit high-capacity values. For instance, many commercially available wall-box chargers for electric cars offer charging capacities in excess of 10 kW, while the typical household contractual network capacity in continental Europe is less than 10 kW³⁴.

³⁴ Assuming that the owner of an electric car travels 12 000 km a year and always charges at home, his or her electricity demand will increase by circa 40 %, while the contracted network capacity could increase by 100 %.

Networks

Matching this growth in electricity demand will require massive investments in electricity generation *and* electricity networks, as well as equally important investments in electrical and thermal energy storage, energy digitalisation and new types of hardware and software. Generation capacity expansion and network expansion must go hand in hand, otherwise it will be physically impossible to meet demand: according to one of Europe's largest utilities, "to meet its renewable energy targets, Germany will have to double its existing 800,000km of distribution networks by 2030"³⁵. And both generation and network expansion must take into account the need for massive deployment of various types of energy storage.

Self-generation is growing rapidly, both in industry and in the residential/services sector (see section below). This approach, based on on-site generation, partially alleviates the need for network expansion, but it does not solve the above-mentioned growing capacity problem arising from new "capacity-intensive" applications such as EV fast charging and heat pumps – not to mention electrolyzers... Moreover, on the supply side, intermittent renewable generation is also "capacity intensive", in the sense that wind and solar electricity generation plants can only feed into the grid for a limited number of hours, thus requiring "over-capacity" - both in generation and in networks – to effectively meet demand. Combining different, complementary renewable energy sources on the same site (so-called hybrid power plants), or nearby, possibly with some storage capacity attached, partially mitigates the need for massive network expansion.

Doubling network capacity in the next 7 years is quite a challenge, especially given that electricity expansion in Europe has been very slow for several decades, following the evolution of electricity demand³⁶:

- Since 2007, electricity demand has been almost flat.
- In the previous 14 years (1994 – 2008), electricity demand grew by only 31%.
- The last boom in electricity demand lasted 7 years (1982-1989) and represented an increase of only 25%.

The network planning methods currently used by network operators have been fine-tuned for slow (or even zero) demand growth and are therefore not suitable for designing the electricity network of 2030. The reason is not only a matter of speed and scale - it is above all a matter of scope: the future network will have to support very different transactions and very different electricity flows in its branches compared to the past; it will have to cope with new injection and demand profiles at its nodes; and it must be able to adapt and remain secure and reliable under fast changing network flows once the digitalisation of energy reaches critical mass. Not to mention the challenges of cyber security.

The network planning and analysis methods currently used by most network

35 Quoted in Financial Times, *Germany's Eon warns of another 'crisis' year for energy sector*, March 15, 2023.

36 EIA, <https://www.eia.gov/international/data/world/electricity/electricity-consumption?pd=2&p=0000002&u=1&f=A&v=line&a=-&i=none&vo=value&t=R&g=none&l=73--73&s=315532800000&e=1609459200000&vb=33&ev=true>

operators are not only unsuitable for future network expansion – they also lock up the physical network capacity currently available, preventing network users from connecting new generation and storage devices to the network.

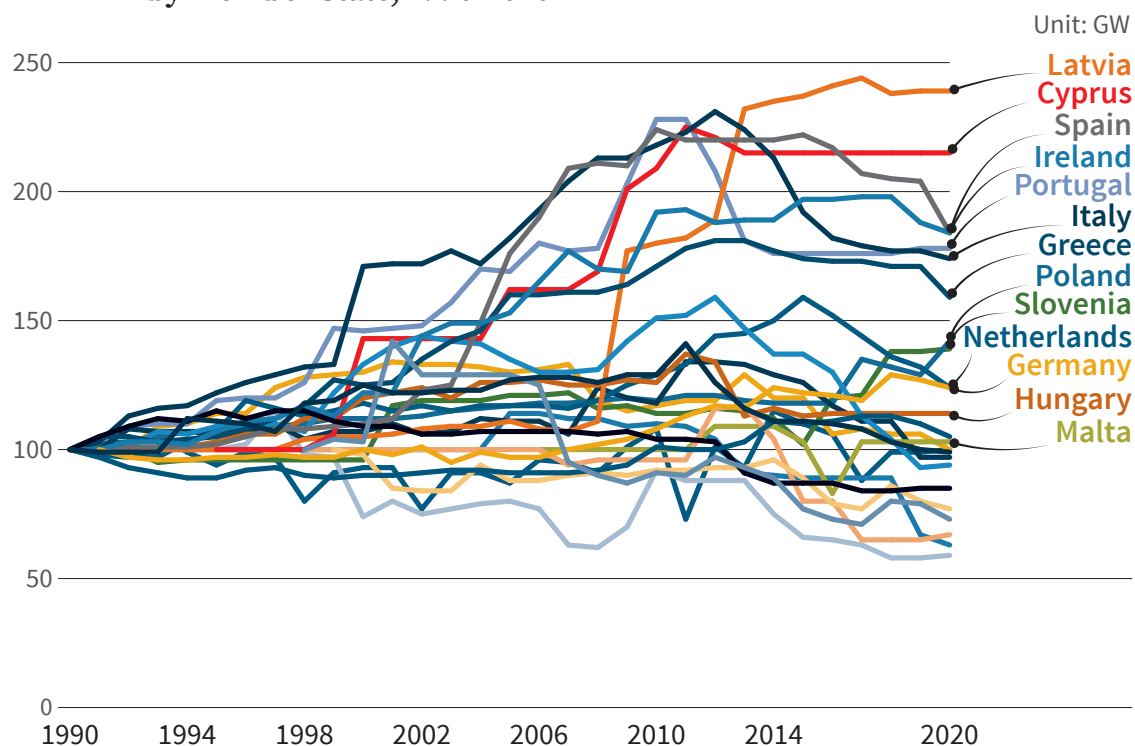
The adoption of new network planning methodologies, for both distribution and for transmission networks, is a prerequisite for efficient network investments – and thus for a timely and cost-effective energy transition.

Main generation

New electricity generation capacity is needed not only to meet new electricity demand, especially as a result of increasing electrification (see Fig. 4 above), but also to replace existing fossil fuel power plants with renewable energy sources.

The next figure shows the evolution of the installed combustible fuels electricity generation capacity owned by main activity producers³⁷, taking 1990 values as 100 (with the exception of 6 countries for which data are not available for some early years – taken as zero in the figure - and Germany, where the base year is 1991 to take account of German reunification; Luxembourg, where capacity increased from 6 MW to 94 MW, i.e., from 100 up to 1 577, is not shown). As can be seen from this picture, 15 Member States have increased their fossil generation capacity while 2 (Finland and Sweden) are at the same level in 2020 as in 1990. Only 10 Member States reduced their combustible fuel electricity generation capacity.

Figure 6 | Evolution of installed fossil fuel electricity generation capacity by Member State, 1990-2020



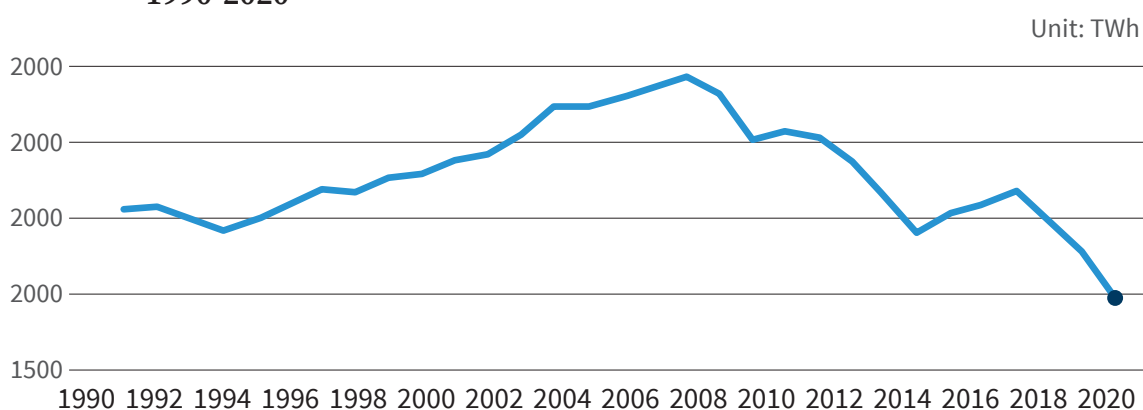
Source: Eurostat

³⁷ Own elaboration based on Eurostat.

In absolute terms, the largest fossil fuel capacity installed by main activity producers in 2020 was in Germany (87 GW, 26% of the total), Italy (55 GW, 16%) and Spain (36 GW, 11%), out of a total (EU-27) of 337 GW. This figure represents an increase of 43% compared to 1990 (252 GW).

Total gross fossil-fuelled electricity generation in the EU-27 increased by 29%, between 1990 and 2007, as shown in the next figure³⁸. However, since then it has been decreasing and in 2020 it is 19 % below the 1990 mark (in 2021 fossil fuel generation increases again, and the reduction compared to 1990 is only 14 %).

Figure 7 | Evolution of total gross electricity generation from fossil fuels EU, 1990-2020



Source: Eurostat

Electricity demand has been relatively stable since 2005. However, as shown in the next figure³⁹, relative to the so-called main activity producers (privately or publicly owned undertakings that generate electricity for sale to third parties, as their primary activity), the structure of EU electricity supply has changed significantly in the 21st century.

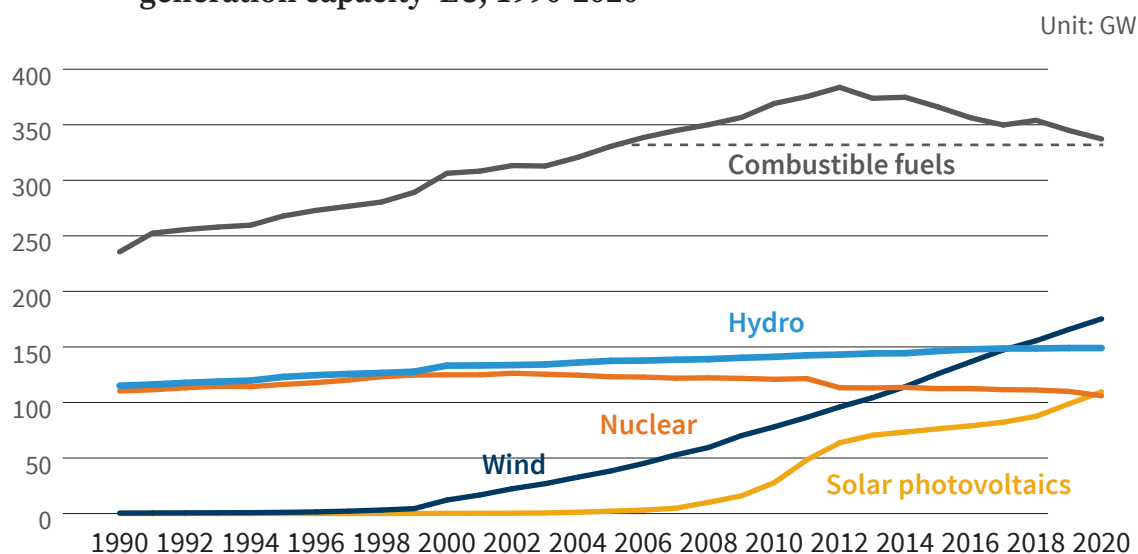
The net installed capacity of fossil fuel power plants increased continuously until 2012, but since then the amount of decommissioning has offset new installations and by the end of 2020 the total installed capacity of fossil fuel power plants was at the level of 2005.

In 2005, solar photovoltaics of the main activity producers took off, following a similar path to wind energy, with a time lag of about 8 years.

³⁸ Own elaboration based on European Commission, *Energy statistical country datasheets* (update 17.08.2022).

³⁹ Own elaboration based on Eurostat.

Figure 8 | **Main activity producers net installed electricity generation capacity EU, 1990-2020**



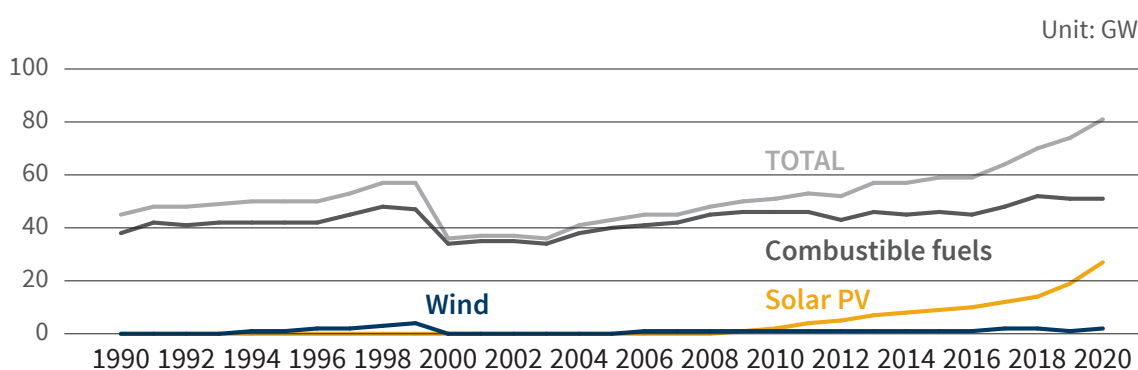
Source: Eurostat

Autoproduction (or self-generation)

Another relevant trend is autoproduction, as shown in the next figure ⁴⁰: in 2000 it amounted to only 36 GW, representing only 6% of the total installed electricity generation capacity in the EU-27; in 2020 the corresponding figures are 81GW and 8%, representing an increase of 125% in this century. By definition, autoproducers are distributed resources.

For solar PV autoproduction in particular, the growth trend started in 2010 and developed very rapidly, with 27 GW of installed capacity at the end of 2020. The energy price crisis in 2021/2022 clearly accelerated this trend, as industry, services and households seek protection against high and highly volatile electricity prices.

Figure 9 | **Autoproducers net installed electricity generation capacity EU, 1990-2020**



Source: Eurostat

⁴⁰ Own elaboration based on Eurostat.

Total electricity generation

In 2020, total installed electricity generation capacity (i.e., including autogenerators) in the EU-27 was as follows⁴¹:

Table 2 | Total installed electricity generation capacity EU, 2020

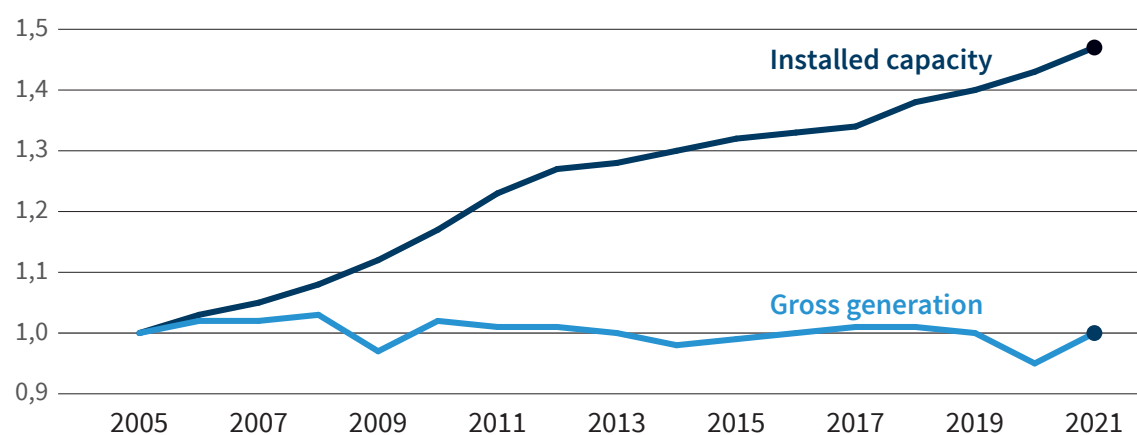
	GW	%
Combustible Fuels	388	40%
Nuclear	106	11%
Hydro	151	16%
Wind	177	18%
Solar PV	136	14%
Solar Thermal	2	0%
Geothermal	1	0%
Tide, Wave and Ocean	0	0%
Other Sources	1	0%
TOTAL	963	100%

Source: Eurostat

Energy decarbonisation implies the retirement of 40% of currently installed electricity generation capacity, equivalent to almost 400 GW of coal and gas power plants.⁴²

Over the last decade and a half, the replacement of combustible fuels by renewable sources for electricity generation to meet flat demand has implied an increase of almost 50% in installed electricity generation capacity, as shown in the next figure ⁴³, where 2005 values are used as a reference.

Figure 10 | Gross generation and installed generation capacity EU, 2005-2021



Source: Eurostat

⁴¹ Own elaboration based upon European Commission, *Energy datasheets: EU countries*, update 29 April 2022.

⁴² In the absence of a significant deployment of Carbon Capture and Storage solutions.

⁴³ Own elaboration based upon European Commission, *Energy datasheets: EU countries*, update 27 April 2023.

Intermittent sources (wind and solar PV) account for almost a third of total installed electricity generation capacity, growing trend. This has important technical and economic implications:

- In terms of technical performance, wind and solar PV exhibit two main differences compared to fossil fuel power plants:
 - 1) the number of hours they can generate electricity is limited by the availability of the associated natural resources⁴⁴;
 - 2) they usually do not provide inertia to the system, a crucial attribute for system stability.

Therefore, these plants need to be complemented by other resources capable of storing or delivering electricity, as well as inertia. In addition, most of these wind and solar power plants are connected at medium and low voltage levels (in Germany, for instance, more than 60% of renewable energy power plants have been connected at these voltage levels every year since 2008). This clearly changes the energy balance between voltage levels and between transmission and distribution networks, requiring less investment in transmission and more investment in distribution.

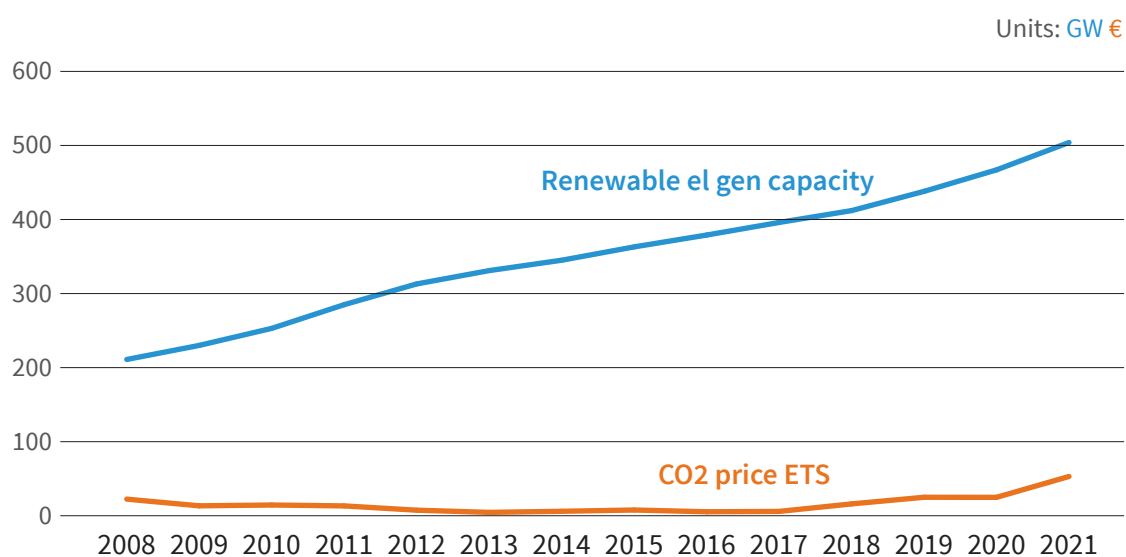
- In terms of economic impact, it should be emphasised that almost all wind and solar PV electricity injected into the grids has a State-guaranteed price, either as a result of auctions and State-guaranteed Contracts for Difference, the old feed-in tariff, or similar mechanisms. Therefore, although the carbon price was important in displacing coal in favour of natural gas in electricity generation⁴⁵, it did not have a significant impact on investment, in renewable electricity generation, as can be seen in the next figure⁴⁶ - investment increased fairly linearly over the period 2008-2021, regardless of whether carbon prices fell, remained stable or rose.

44 For instance, in 2020, although wind and solar PV represented 32% of total installed electricity generation capacity (see Table 2), they only contributed with 19% to total gross electricity generation (European Commission, *Energy statistical country datasheets* (update 17.08.2022)). In the same year, fossil fuel power plants, representing 40% of installed capacity, contributed with 34% to total gross electricity generation, while for nuclear power plants the corresponding figures were 11% and 25%.

45 According to the European Commission, the EU Emissions Trading System (EU ETS) “is a cornerstone of the EU’s policy to combat climate change and its key tool for reducing greenhouse gas emissions cost-effectively. It is the world’s first major carbon market and remains the biggest one” (https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en). The EU success over the last decades is undeniable: “Greenhouse gas emissions in the EU decreased by 32% between 1990 and 2020, a notable overachievement of the EU’s 2020 reduction target of 20%.” (<https://www.eea.europa.eu/ims/total-greenhouse-gas-emission-trends>). However, it failed influencing the development of wind and solar electricity generation.

46 Own elaboration based on European Commission, *Energy datasheets: EU countries*, update 27 April 2023, for installed generation capacity, and FactSet and Bloomberg, New Energy Finance, for carbon price. 2008 values of installed renewable electricity generation capacity and ETS carbon price were used as reference.

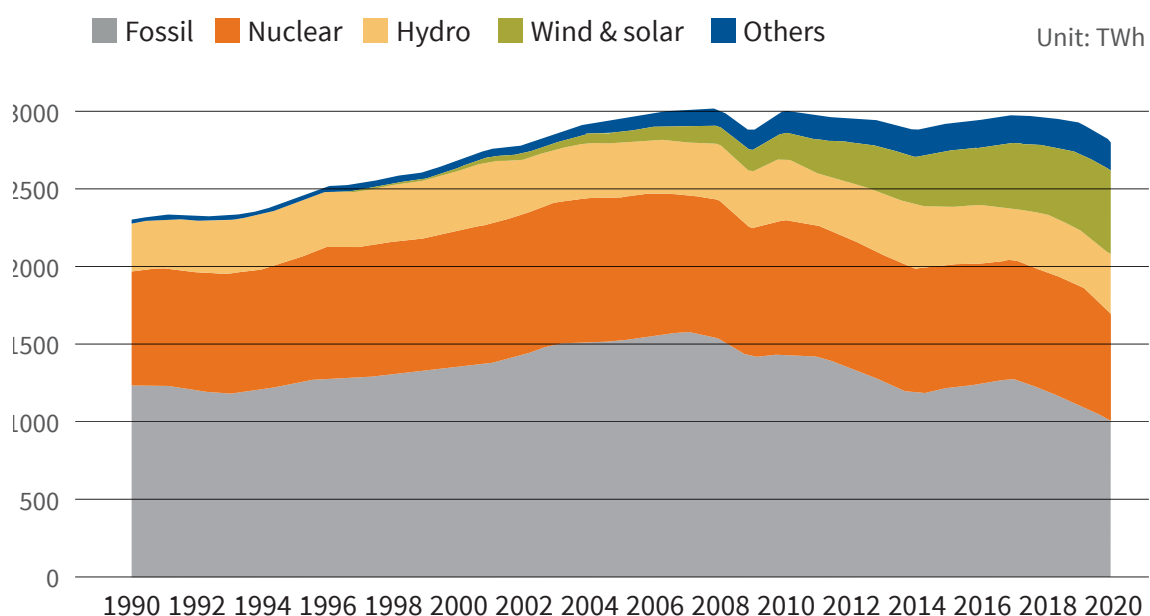
Figure 11 | **Evolution of renewable electricity generation capacity and CO2 price EU, 2008-2021**



Source: Eurostat

The evolution of gross electricity generation in the EU can be observed in the following figures⁴⁷, which clearly show the increasing weight of intermittent solar and wind energy sources in the EU-27 electricity mix.

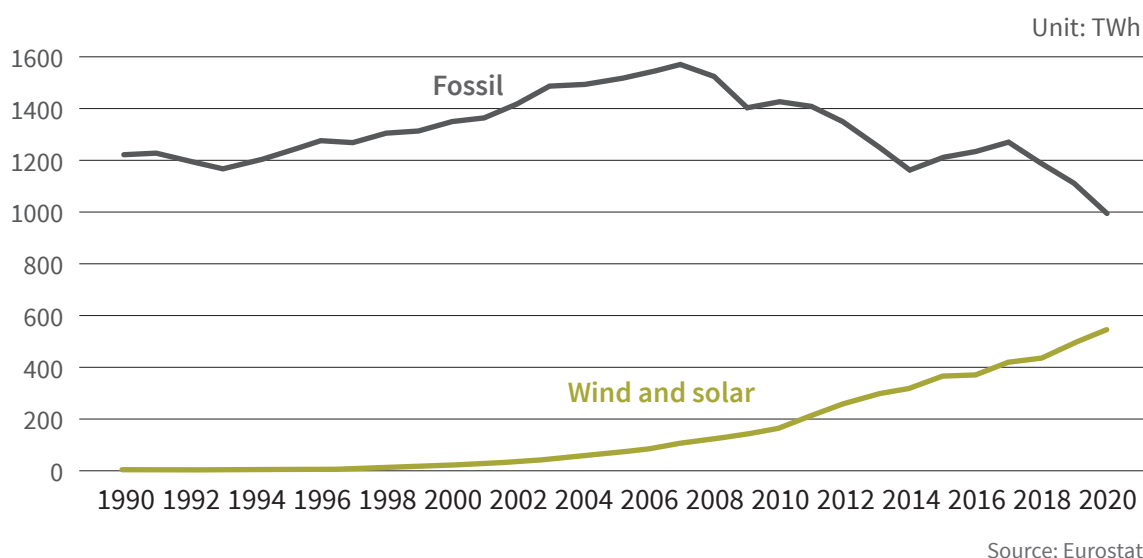
Figure 12 | **Evolution of gross electricity generation by source EU, 1990-2020**



Source: Eurostat

⁴⁷ Own elaboration based on European Commission, *Energy statistical country datasheets* (update 17.08.2022).

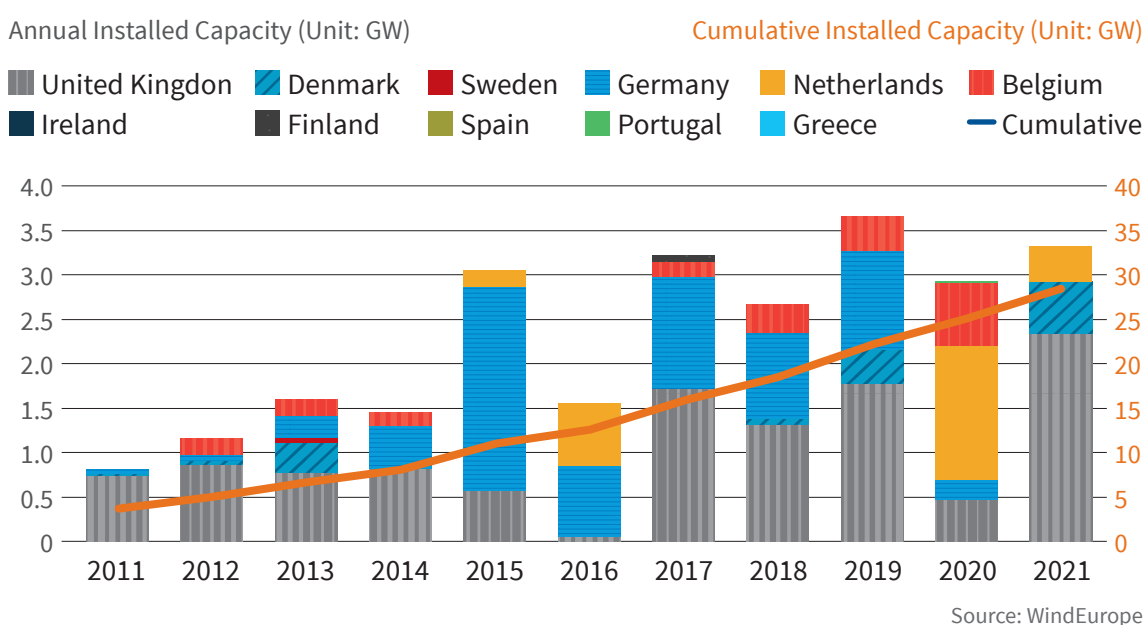
Figure 13 | **Evolution of gross electricity generation (fossil vs. wind&solar) EU, 1990-2020**



Hyper-generation

The previous paragraphs have illustrated the pace of decentralisation of electricity generation resources in the EU-27 due to wind and solar PV expansion, which has been especially notable since 2010. More recently, however, another trend has emerged that points in the opposite direction, i.e., towards the creation of hyper-centralised offshore power plants. This trend is illustrated in the next figure⁴⁸.

Figure 14 | **Offshore wind generation capacity in selected European countries, 2011-2021**



48 <https://windeurope.org/policy/topics/offshore-wind-energy/>

The EU strategy for offshore renewable energy⁴⁹ foresees an installed capacity of at least 60 GW of offshore wind by 2030, and 300 GW by 2050. Several projects have been announced in recent months, usually with high-level national or multinational political support:

- On September 12, 2022, the North Seas Energy Cooperation members (Belgium, Denmark, France, Germany, Ireland, Luxembourg, the Netherlands, Norway, Sweden and the European Commission) agreed in a joint statement⁵⁰ to achieve at least 260 GW of offshore wind energy by 2050, with intermediate targets of at least 76 GW by 2030 and 193 GW by 2040.
- Belgium expects wind energy from the Belgian North Sea to cover around 30% of national electricity demand by 2030 (equivalent to 6 - 8 GW of offshore wind capacity)⁵¹.
- In the Netherlands, “some 21 GW’s worth of offshore wind farms will need to be in operation around 2030, which is enough to supply 16% of all the energy in the Netherlands and 75% of current electricity consumption”⁵².
- The Baltic Sea has a potential of 93 GW, according to the Baltic Energy Market Interconnection Plan (BEMIP) Member States (Denmark, Germany, Estonia, Latvia, Lithuania, Poland, Finland and Sweden and Norway as an observer)^{53 54}.
- Portugal will launch an auction for 10 GW of offshore wind capacity in 2023⁵⁵.
- The UK aims to have 50 GW of offshore wind capacity operational by 2030⁵⁶.

Hyper-centralisation brings new challenges to network planning and system operation. These new challenges, composed with the already known – though not yet properly addressed - challenges of massive decentralisation, require the adoption of new:

- Network planning methodologies.
- Dispatching and contingency criteria.
- Regulatory incentives for network expansion.

49 European Commission, *An EU Strategy to harness the potential of offshore renewable energy for a climate neutral future*, COM(2020) 741 final of 19.11.2020

50 https://energy.ec.europa.eu/system/files/2022-09/220912_NSEC_Joint_Statement_Dublin_Ministerial.pdf

51 <https://www.belgianoffshoreplatform.be/en/>

52 <https://www.government.nl/topics/renewable-energy/offshore-wind-energy>

53 https://commission.europa.eu/document/download/f6ccfa8b-455b-452c-b55b-5d3a421c368b_en?filename=final_bemip_offshore.pdf

54 <https://op.europa.eu/en/publication-detail/-/publication/9590cdee-cd30-11e9-992f-01aa75ed71a1>

55 <https://www.reuters.com/business/sustainable-business/portugal-ops-debut-offshore-wind-auction-target-10-gw-2022-09-21/>

56 <https://www.great.gov.uk/international/content/investment/sectors/offshore-wind/>

Price signals and subsidies

Energy subsidies are a persistent reality worldwide, including in the EU:

“The overall amount of energy subsidies in EU27, €159 billion in 2015, has constantly grown (1.8% CAGR) since then reaching €173 billion in 2020. (...)”

Total fossil fuel subsidies paid have remained relatively stable at around €52 billion per year until 2019 before recording a €3 billion fall (-5%) in 2020, which was caused by a €3 billion reduction in subsidies allocated to the transport sector, in the context of COVID-19 pandemic and lockdown measures.

Support to renewables was still slightly on the rise until 2020 mainly throughout market-based instruments including feed-in tariffs/premiums, contracts for difference and RES quotas.”⁵⁷

In 2020 alone, subsidies to renewable energy sources amounted to 80 bn euro, representing 47% of total EU-27 energy subsidies⁵⁸.

Why are these subsidies necessary? The European Court of Auditors recently gave a clear answer:

“Over the last ten years, growing state aid schemes to support investment in green electricity capacities showed that market prices did not ensure sufficient market-based remuneration for such investments.”⁵⁹

This problem is well known: back in 2015, the European Commission staff recognised that “In the long run, the challenge will be to put in place market arrangements that provide sufficient revenues for investments to take place without any form of State intervention. Given the investment challenges that successful decarbonisation may create, there is a need to start reflecting on the most suitable market arrangements for the transition phase and on the type of market arrangements that Europe will need once it has reached its decarbonisation goals.”⁶⁰

Unfortunately, this reflection has not taken place, with the dominant position being that “[s]hort-term markets, notably intraday and balancing markets, must be at the core of an efficient electricity market design”⁶¹ and “The establishment of liquid and better integrated short-term markets will help increase flexibility and allow renewable energy producers to compete on an equal footing with conventional energy producers”⁶². This perspective, which prevents any serious debate on “the type of market

57 European Commission, *Study on energy subsidies and other government interventions in the European Union – 2022 edition*, Final Report, 2022. Pg. 59.

58 Ibid., pgs. 36 and 50.

59 European Court of Auditors, *Internal electricity market integration*, Special report 03, 2023. Pg. 31. https://www.eca.europa.eu/Lists/ECADocuments/SR23_03/SR_Energy_Union_EN.pdf

60 European Commission, Commission Staff Working Document, *Investment perspectives in electricity markets*, SWD(2015) 142 final, 15.7.2015. Pg. 3.

61 European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, *Launching the public consultation process on a new energy market design*, COM(2015) 340 final, 15.7.2015. Pg. 5.

62 Ibid., pg. 7.

arrangements that Europe will need once it has reached its decarbonisation goals” and ignores the fact that “conventional energy producers” will soon have to shut down if decarbonisation goals are to be achieved, is the vision embodied in the 2019 electricity market directive.

The 2021/2022 energy price crisis has shown how dangerous short-termism is, failing to deliver not only on energy decarbonisation, but also on affordable energy prices. The political response to these failures has been massive subsidies, not only to generators, but also to consumers⁶³.

More recently, first in the 2022 REPowerEU document and then in the March 2023 “Proposal for an amending Regulation to improve the Union’s electricity market design”, the European Commission has abandoned short-termism and reintroduced the long-term dimension into the debate and into the legislative process.

⁶³ “As of June 2022, we estimate that around €76 billion in subsidies were paid in the EU27 in 2021 and 2022 to address rising energy prices.” European Commission, *Study on energy subsidies and other government interventions in the European Union – 2022 edition*, Final Report, 2022. Pg. 59.

PART I

Key principles

1. SUBSIDIARITY

Article 5(1) of the Treaty on European Union states that “[t]he use of Union competences is governed by the principles of subsidiarity and proportionality”, while Article 5(3) states that “[u]nder the principle of subsidiarity, in areas which do not fall within its exclusive competence, the Union shall act only if and in so far as the objectives of the proposed action cannot be sufficiently achieved by the Member States, either at central level or at regional and local level, but can rather, by reason of the scale or effects of the proposed action, be better achieved at Union level.”

It is important to recognise that when discussing network industries such as electricity, the application of the subsidiarity principle requires not only constitutional and economic aspects to be taken into account, but also technical and scientific aspects related to the functioning of the physical network.

The analysis of a physically interconnected electricity network – for example, the assessment of its present or future stability – requires the assembly of a set of equations incorporating physical information from all the nodes and branches of the network, irrespective of national borders, ownership of assets, market structure, and so on. To answer the question “is the interconnected electrical system stable under a given set of expected demand and generation conditions?”, these equations must be solved simultaneously. Therefore, without sharing data with all interconnected network operators, no single national network operator is able to assess system stability (or any other relevant system performance indicator). This is a clear case where the central Union level is the most appropriate – indeed, the only level at which a full analysis of the electricity system can be properly carried out.

Stability is a public good – if one part of the interconnected system is unstable, then the whole system is unstable and will eventually collapse. Therefore, the ability to predict stability and to take the necessary stabilisation measures when needed is critical – and time is of the essence. The faster and more accurately the state of the electrical system can be known and predicted, the more reliable it will be – and the more efficient the use of available resources (network, generation, etc.).

It is possible to operate an interconnected system with limited data exchange, as was done before the widespread use of computers and modern information and communication technical solutions, but this entails higher risks and lower economic and technical efficiency. It is also possible to manage interconnected electricity systems through groups of “regional coordination centres”, as provided for in Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity (recast), but this is also a sub-optimal approach⁶⁴.

⁶⁴ The idea of regional zones as exceptions to a uniform – and unifying, in the EU case – legal paradigm, belongs to a certain recent ideological trend “to pierce holes in the social fabric, to opt out, secede, and defect from the collective”, very well described in Quinn Slobodian, *Crack-up capitalism. Market radicals and the dream of a world without democracy*. Allen Lane, 2023, (pg. 4).

It is impressive that while the first electricity directive, in 1996, never mentioned the words zone or region, Regulation (EU) 2019/943 includes the words zone(s) 86 times and region or regional 295 times. This “zonification” or “regionalisation” of the Internal Energy Market started around 2005 and consolidated in 2019; it shall not be confused with the decentralisation approach described and advocated in the present report (see next Chapter) and in many other places. True decentralisation is based upon two main facts: 1) final energy demand is mainly a local (i.e., urban)

Coordinating the planning and operation of the EU's interconnected electricity system is a task that can undoubtedly "be better achieved at Union level". It should therefore be fully assigned to the EU level through the creation of a new European Independent System Operator (EISO).

The European Independent System Operator shall be subject to independent regulation in the same way as national network operators are subject to regulation by National Regulatory Authorities. Therefore, a new European Energy Regulatory Agency is needed, to properly establish and enforce rules related to the tasks of the EISO in particular and to cross-border issues in general. This body should be independent not only from the regulated industry, but also from the European Commission and the National Regulatory Authorities who remain fully responsible for national regulatory issues.

From a legal point of view, according to Article 194 of the Treaty on the Functioning of the European Union, Member States have the "right to determine the conditions for exploiting its energy resources, its choice between different energy sources and the general structure of its energy supply" (Article 194(2)). On the other hand, according to the same Article (Article 194(1)), "In the context of the establishment and functioning of the internal market and with regard for the need to preserve and improve the environment, Union policy on energy shall aim, in a spirit of solidarity between Member States, to:

- (a)** ensure the functioning of the energy market;
- (b)** ensure security of energy supply in the Union;
- (c)** promote energy efficiency and energy saving and the development of new and renewable forms of energy; and
- (d)** promote the interconnection of energy networks."

In essence, the Treaties address the issue of the division of competences between the EU and national levels. However, local authorities have a crucial role to play in any successful energy transition towards carbon neutrality. Therefore, it is also very important to address the question of the division of competences between national and local levels. This is discussed in the following chapters, from an energy efficiency perspective (Ch. 2) and from a political point of view (Ch. 3).

reality and 2) over the last decade, energy resources (namely photovoltaics, electric vehicles and heat pumps), have been mainly deployed at low and medium voltage distribution level (as opposed to high voltage transmission), trend growing. On the contrary, "zonification" and "regionalisation" represent a departure from the Single Market initial approach, aimed at consolidating and legitimating the existing fragmentation, mainly due to fragmented network infrastructures. "Zonification" means giving up the project of a unified (and unifying) Single Market, both in physical and in institutional terms, devolving "power" to national governments, through small intergovernmental fora, for the sake of further renationalising energy policy.

The following, non-exhaustive, table shows how key functions related to energy systems can be allocated to three different decision-making levels (EU, national and local). These functions are divided into political and technical categories.

Table 3 | **Allocation of key energy system functions to different decision-making levels**

Level	Function	
	Political	Technical
EU	Ensure the functioning of the energy market	Coordinate system operation (European Independent System Operator) Regulate coordinated system operation and cross-border issues (European Energy Regulatory Agency)
	Ensure security of energy supply in the Union	Coordinate system planning and operation Establish EU indicators
	Promote energy efficiency and energy saving and the development of new and renewable forms of energy	Ensure that infrastructure enables reaching the goals
	Approve “EU fossil fuel electricity generation plants phasing-out plan”	Prepare and monitor implementation of “EU fossil fuel electricity generation plants phasing-out plan”
	Approve “EU electricity transmission and distribution network expansion plan”	Prepare and monitor implementation of “EU electricity transmission and distribution network expansion plan”
National	Determine conditions for exploiting energy resources	Approve national energy infrastructure investment plan
	Choose between different energy sources (e.g., nuclear, off-shore wind)	
	Determine general structure of energy supply	Coordinate national and local energy platforms
	Define and implement National Energy and Climate Plan	
Local	Determine choice between different local energy sources and infrastructures	Coordinate local energy-related infrastructure planning
	Define and implement Sustainable Energy and Climate Action Plan	Coordinate national and local energy platforms
	Determine local structure of energy supply	Coordinate operation of local integrated energy system

2. EFFICIENCY

As Frank Willczek, winner of the 2004 Nobel Prize in Physics, put it, “[e]nergy, as a physical concept, has a bizarre history”⁶⁵. One thing is certain: energy transformations “always involve *loss of energy*” and that is the reason why “one should focus on the price of energy, in any of its forms, and on minimizing the losses”⁶⁶. The benefits of minimising losses are not only economic, but also environmental (e.g., less pollution and less use of raw materials) and political (e.g., reducing energy imports reduces dependence on energy-exporting countries). Given the scale of the challenges ahead, the design of energy transition processes, and in particular the integration of energy systems, must rely on systematic reduction of energy losses, i.e., on the energy efficiency first principle.

Efficiency, either in a strict physical sense or in a broader sense, has always been part of the Internal Energy Market, as the following examples show:

- The 1996 electricity directive stated that the “establishment of the internal market in electricity is particularly important in order to increase efficiency in the production, transmission and distribution of this product” (Whereas 4).
- Twenty years later, the 2016 “Clean energy for all Europeans” package was even more ambitious, asserting “Energy efficiency first”.

The provisional agreement reached in March 2023 between the EU co-legislators on the recast of the energy efficiency Directive⁶⁷ states (emphasis added):

“In conformity with the **energy efficiency first principle**, Member States shall ensure that energy efficiency solutions, including demand-side resources and system flexibilities, are assessed in the planning, policy and major investment decisions of a value of more than 100 million euro each or 175 million euro for transport infrastructure projects, related to the following sectors:

- (a) energy systems, and
- (b) non-energy sectors, where those sectors have an impact on energy consumption and energy efficiency such as buildings, transport, water, information and communications technology (ICT), agriculture and financial sectors.”⁶⁸

Moreover (emphasis added):

“Member States shall ensure that the relevant authorities monitor the application of the energy efficiency first principle, including, where appropriate, **sector integration and cross-sectoral impacts**, where policy, planning and investment decisions are subject to approval and monitoring requirements.”⁶⁹

⁶⁵ Frank Willczek, *A beautiful question. Finding nature's deep design*, Allen Lane, UK, 2015. Pg. 281.

⁶⁶ Ibid, pg. 284.

⁶⁷ Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amended several times since then: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32012L0027>

⁶⁸ <https://data.consilium.europa.eu/doc/document/ST-7446-2023-INIT/en/pdf> Article 3, nr. 1.

⁶⁹ Ibid., Article 3, nr. 2

The application of the “energy efficiency first” principle is crucial for efficient and effective energy system integration. In other words, the efficiency principle should guide basic cross-sectoral policy choices (to decarbonise what, how much, when, how...) and shape energy system integration (planning, investment decisions, organisation of technical and market coordination).

The following paragraphs substantiate the previous statement.

Technical efficiency can be defined at the level of individual appliances (motor, generator, battery, light bulb, etc.) or at system level (vehicle, house, factory, power plant, etc.). In energy systems, overall efficiency depends not only on the efficiency of individual components, but also on the way these components are combined. Energy systems can be defined at different scales and have different degrees of complexity – as well as different levels of efficiency.

Within electricity systems, in the old days of conventional power plants, technical efficiency was addressed separately in three distinct areas:

- Generation: the efficiency rate of fossil-fuel power plants increased over time.
- Networks: lines and substations were designed to minimise the (economic value of) energy losses.
- Demand: efficiency was increased everywhere - industry, buildings (households and services), public lighting, etc.-, mainly thanks to upgraded appliance efficiency standards⁷⁰.

In the 1980s, following the two previous oil shocks, efficiency was high on the political agenda and many policy makers and regulators imposed the adoption of so-called “Integrated Resource Planning”, i.e., considering the possibility of “demand management” (through various methods and incentives) and combining generation with “manageable demand”, rather than treating the two separately. The aim was to increase overall efficiency and reduce the amount of primary energy (and capital) needed to satisfy end users, mainly by reducing or shifting “peak demand”. At the same time, the first incentives for renewable energy and cogeneration (i.e., simultaneous generation of heat and electricity) were introduced in several countries around the world, with the same aim of reducing (fossil) primary energy demand. Energy efficiency standards for several appliances were also tightened or introduced for the first time.

70 Although there was a strong focus on efficiency, the sufficiency principle was very often ignored, namely as regards buildings, urban planning and transport.

“Sufficiency policies are a set of measures and daily practices to avoid the demand for energy, materials, land, water, and other natural resources over the lifecycle of buildings and goods while delivering wellbeing for all within planetary boundaries.” (Intergovernmental Panel on Climate Change, Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, pg. 957 https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Chapter09.pdf). As regards buildings, it is worth recalling that

“Our built environment is a massive burden on the planet. In the European Union, it requires vast amounts of resources and accounts for about 50% of all extracted material and 40% of the energy consumption. Despite progress in reducing energy demand in European buildings, overall CO2 emissions per capita have continued to increase in recent years driven mostly by two trends: growing consumption patterns and expanding average floor area per capita in certain areas.” (European Environmental Bureau <https://eeb.org/sufficiency/>).

In the present century, the large-scale deployment of intermittent renewable power plants has introduced a new challenge, namely the need to match electricity demand with available renewable electricity generation. Whereas in the past generation followed demand, today demand should follow generation to a certain extent – otherwise curtailment of intermittent generators at peak generation times becomes prohibitive. Because aggregate generation patterns change with changes in the amount and mix of renewable electricity generation - and also because networks have not yet been adequately adapted to dramatic changes on the generation side - adapting electricity demand to these new constraints is a daunting task. In different jurisdictions, policy makers and regulators have introduced so-called “flexibility” mechanisms to enable a better match between (intermittent) supply and demand resources. However, these *ad hoc* mechanisms have been designed, in different ways, as a band-aid solution to a much deeper structural problem; these mechanisms tend to be more concerned with short-term operational relief than with long-term energy efficiency.

The ongoing process of electrification of mobility and heating/cooling adds a new challenge in both quantitative and qualitative terms. Roughly speaking, the electrification of these energy uses implies a doubling of current electricity demand, requiring a rapid and coordinated expansion of electricity generation *and* network resources. On the other hand, the demand patterns of electric mobility and electric heating are different from “traditional” electricity demand curves and have different probabilistic features. Moreover, the electrification of mobility and heating comes with relatively huge electrical and thermal storage capacities attached that must be properly taken into account. Meanwhile, other electrical storage resources are spreading very rapidly, both at user and utility level.

In short:

- The electrification of mobility and heating/cooling changes the size and dynamics of the electricity system in a substantial, structural way; therefore, energy efficiency takes on a new meaning, both in the planning and in the operational stage.
- Energy efficiency must be a guiding principle not only for the operation of any integrated (i.e., post-electrification) energy system, but also for the integrative process leading to the integrated energy system itself.

The next figure is a stylised representation of the previous paragraphs, describing the evolution of installed electricity generation capacity in relation to electricity demand, highlighting the role of different energy policies.

Until around 2005, electricity demand in the EU continued to grow, leading to a similar increase in installed electricity generation. Thanks to a certain degree of IRP (Integrated Resource Planning), namely peak demand management (in particular peak shaving – mainly through interruptible contracts - and peak shifting), it is estimated that installed capacity grew slightly less than it would have been necessary without such measures. Since 2005, yearly electricity demand has been very stable at around 2 470 TWh, thanks to the increased efficiency of electrical appliances in line with increasingly stringent efficiency standards. During this period, however, electricity

generation capacity has increased significantly, as shown earlier in Figure 7: between 2005 and 2020, total installed capacity has increased by 42%, mainly due to new wind and photovoltaic power plants. Looking ahead, the electrification of mobility and heating and cooling translates into a substantial increase of electricity demand, which will have to be met by additional wind and solar generation capacity. Given the characteristics of these power plants, the expected increase in generation capacity would be huge (point A in the figure); to reduce the amount of generation capacity to a more reasonable level (point B in the figure), a very strong efficiency policy must be implemented – i.e., the energy efficiency first principle must be applied.

Figure 15 | **Stylised description of efficiency impact upon electricity generation and demand**

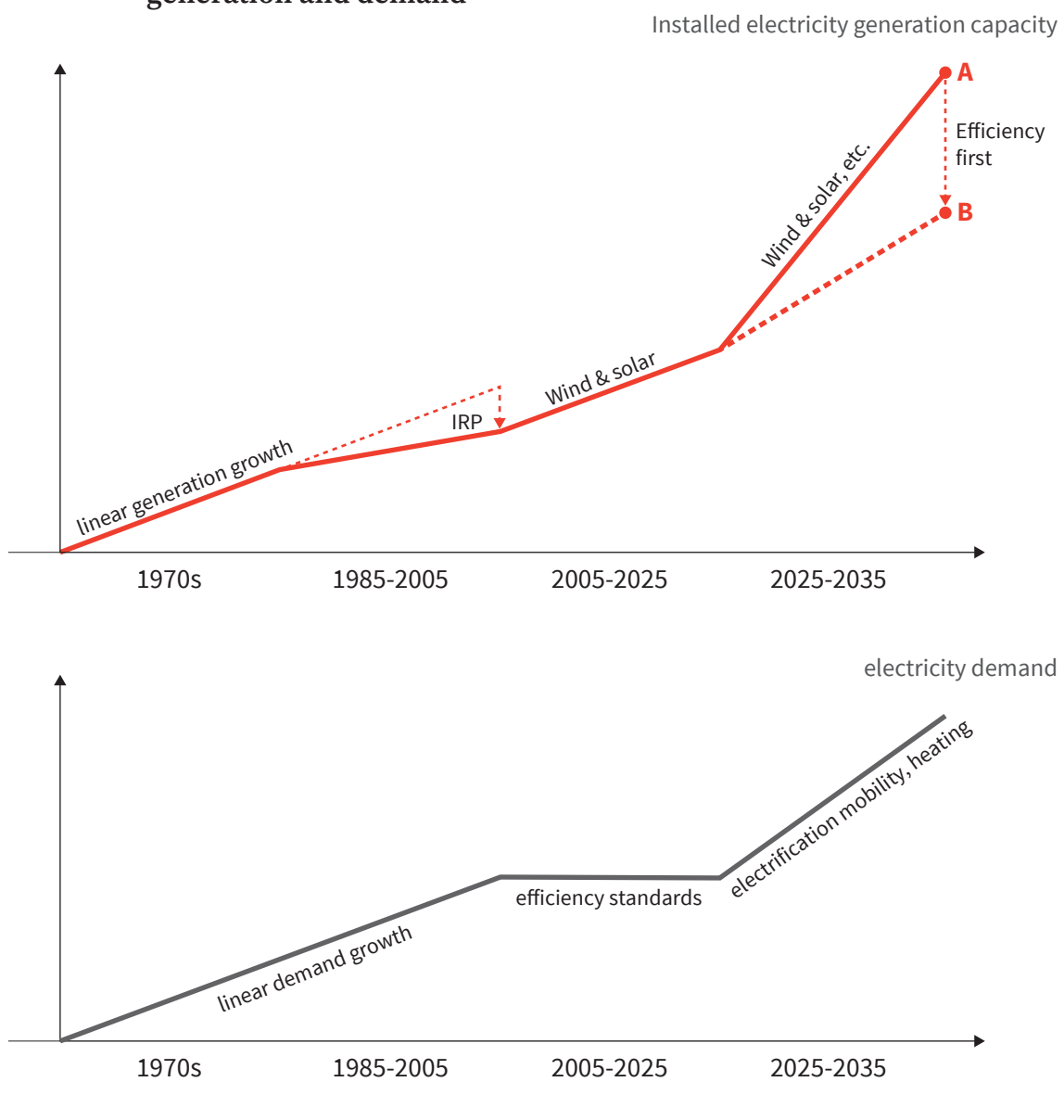


Figure 9 in Ch. 0 Introduction shows actual figures for total gross electricity generation and total installed electricity generation capacity over the period 2005-2021, with 2005 as the reference year in both cases. While generation is at the same level in 2005 and 2021, total installed electricity generation capacity increased by 47 % over the period.

Between 2007 and 2021, fossil generation decreased by 517 TWh and wind and solar generation increased by 447 TWh (a relative increase of 431 %); this intermittent generation is mainly connected to low and medium voltage electricity networks. As a result, in countries where decarbonisation is most advanced, electricity flows between high and medium voltage networks are now bidirectional, replacing long-standing, top-down, unidirectional patterns. On the other hand, the increasing demand for electricity due to the electrification of mobility and heating/cooling takes place at the same voltage levels, mainly in urban areas, where most residential and service buildings are located.

As most new electricity demand and generation occurs at the low/medium voltage level, creating “clusters” of highly concentrated demand and generation resources, the application of the energy efficiency first principle must start at this level, i.e., at the local level.

The design and operation of local platforms to support growing volumes of local electricity flows, increasingly differentiated electricity uses and mounting complexity of digitally interconnected and software-controlled devices must be guided by the energy efficiency first principle within the framework of a local circular economy approach.

Two final remarks on efficiency:

I.

When facing a transition, it is important to recognise the difference between:

- Efficiency according to current boundary conditions.
- Efficiency according to future (partly unknown) boundary conditions.⁷¹

The energy transition is about adapting energy systems to future boundary conditions, promoting change at multiple scales, not about how to further reduce energy losses under current boundary conditions.

The current transition involves new energy sources and new resources (e.g., storage, multi-level real-time control); adaptation is about coping with new problems and managing new technical solutions, not just about adding new energy sources, as in previous energy transitions: “Throughout human history, when one source of power

⁷¹ Mario Giampietro and Kozo Mayumi, *A dynamic model of socioeconomic systems based on hierarchy theory and its application to sustainability*, Structural Change and Economic Dynamics, 8 (1997) 453-46.

proved insufficient, a new one was *added* (...) The old sources of power were not abandoned.”⁷² The current transition is not about expanding supply and abandoning some energy sources, but about efficiency, i.e., doing more with less – less primary energy, less greenhouse gas emissions, less negative externalities. In this context, efficiency obviously includes sufficiency as a very first step to be considered.

II.

Energy is only one dimension of the urban metabolism. A holistic approach to urban metabolism must consider not only energy efficiency, but also material cycles, water and waste management, and infrastructure development. Quantitative analysis of social systems such as cities and regions requires appropriate models and accounting rules. While several models can coexist, accounting rules should be harmonised across the European Union.

72 Adrian Bejan and J. Peder Zane, *Design in nature*, Anchor Books, N.Y., 2013. Pg. 258.

3. DEMOCRATISATION

Climate policy and the reduction of greenhouse gas emissions impact several sectors and regions. National policies and targets are usually translated into local policies and plans, but sometimes local communities and local authorities anticipate and/or go beyond national policies by developing their own approaches to the relevant public policies. The crucial role of cities in this context, namely as promoters of innovative solutions, has been recently recognised by the European Commission, for example through the creation of a new EU Mission for climate-neutral and smart cities by 2030:

“The Commission will invite the 100 selected cities to develop Climate City Contracts, which will include an overall plan for climate neutrality across all sectors such as energy, buildings, waste management and transport, together with related investment plans. This process will involve citizens, research organisations and the private sector. The clear and visible commitments made by the cities in the Climate City Contracts will enable them to engage with the EU, national and regional authorities – and most importantly with their own citizens to deliver on this ambitious objective.”⁷³

Citizen awareness and engagement at local level is essential for a successful – i.e., fair and efficient – energy transition towards carbon neutrality. This process needs to be analysed not only from a technical standpoint, but above all from a political economy perspective. Engagement encompasses the creation of energy communities and other forms of participation, as well as the establishment of local market-based platforms.

Organised in energy communities, citizens become key actors in the necessary transformation. Digitalisation is a powerful support tool, but leadership is crucial: “Community organization consists essentially of lowering mobilization costs by creating leadership, establishing communications lines and feeding in information.”⁷⁴ Nowadays, communities are not just a nice incarnation of social capital, but a mixture of social and financial capital:

“[T]he democratization of communication, energy, and transportation allows billions of people to be individually “empowered”. But that empowerment is only achievable by one’s participation in peer-to-peer networks that are underwritten by social capital. A new generation is coming of age that is more entrepreneurially self-directed by means of being more socially embedded. It’s no surprise that the best and brightest of the Millennial Generation think of themselves as “social entrepreneurs”. For them, being both entrepreneurial and social is no longer an oxymoron, but rather a tautology.”⁷⁵

Energy communities are a powerful tool for shaping the energy transition. However, other forms of participation are also needed, particularly in defining and implementing

⁷³ “Commission announces 100 cities participating in EU Mission for climate-neutral and smart cities by 2030” of 28.04.2022 https://ec.europa.eu/commission/presscorner/detail/en/IP_22_2591

⁷⁴ Charles Tilly, *Do communities act?*, Sociological Inquiry, Volume 43, Issue3-4, July 1973.

⁷⁵ Jeremy Rifkin, *The zero marginal cost society*, St. Martin’s Griffin, N.Y. 2015. Pg. 24.

local platforms for energy system integration. Energy system integration requires the coordination of a large number of policy decisions, in particular in the field of urban planning: where and how (i.e., according to which energy standards) houses can be built, how urban transport is organised and interfaced with regional and national/international transport networks, how heating and cooling is provided to households, commercial and public buildings, how water and waste are managed, and so on.

Citizens democratically debate and vote on how to manage natural resources, including energy, at both national and local levels. Collectively, they shape the energy landscape of their country and the region in which they live.

Energy decentralisation is a consequence of technical evolution and it is better framed, from a technical point of view, by the systematic application of the “energy efficiency first” principle, as explained in the previous chapter. Energy decentralisation allows for a greater involvement of citizens, thus improving the legitimacy and effectiveness of the energy transition process, as argued in this chapter.

Decentralisation is not a threat to the Internal Energy Market or to the European Union or to national sovereignty. On the contrary, “[i]f the state is to discharge its role in stabilizing a system of law under which its citizens enjoy security in relation to one another and in relation to officials, then [the state] must be a corporate agent that operates under a decentralized – ideally a moderately decentralized – constitution”⁷⁶. In fact, “[t]here is no reason why the decision-making procedures it [a polycentric polity] establishes, empowering several distinct agents or agencies, should not be able to generate a relatively coherent pattern in the framing and interpretation of decision-taker laws. There is no reason, in other words, why this state should not speak with a single, univocal voice. Thus, to take the simplest example, a state that divided the business of framing law between two distinct bodies, one authorial, the other editorial, might be very successful in generating an internally coherent body of law.”⁷⁷

Citizens are also consumers – of different services and products, including electricity; in liberalised sectors, such as electricity in the EU, they can express their preferences by choosing different suppliers and tariffs, and react differently to different price signals.

An efficient transition to decarbonisation requires that price mechanisms and public policies are aligned. This is particularly important in view of the ongoing massive electrification of mobility and heating/cooling, which requires coherent price signals both for the use of existing electricity networks and for investments in their expansion and digitalisation.

In the past, when energy silos were managed independently, very often subsidies, taxes and other policy instruments influencing retail energy prices very often created serious distortions in fuel-to-fuel competition. To enable and accelerate an efficient transition to decarbonisation through energy system integration such distortions need to be removed - a level playing field, consistent with public policy goals for 2030 and 2050, is essential. This requires appropriate coordination between local and national authorities to harmonise fiscal policies, subsidies and, where appropriate, concession contracts.

⁷⁶ Philip Pettit, *The state*, Princeton University Press, 2023. Pg. 170.

⁷⁷ Ibid., pg. 155.

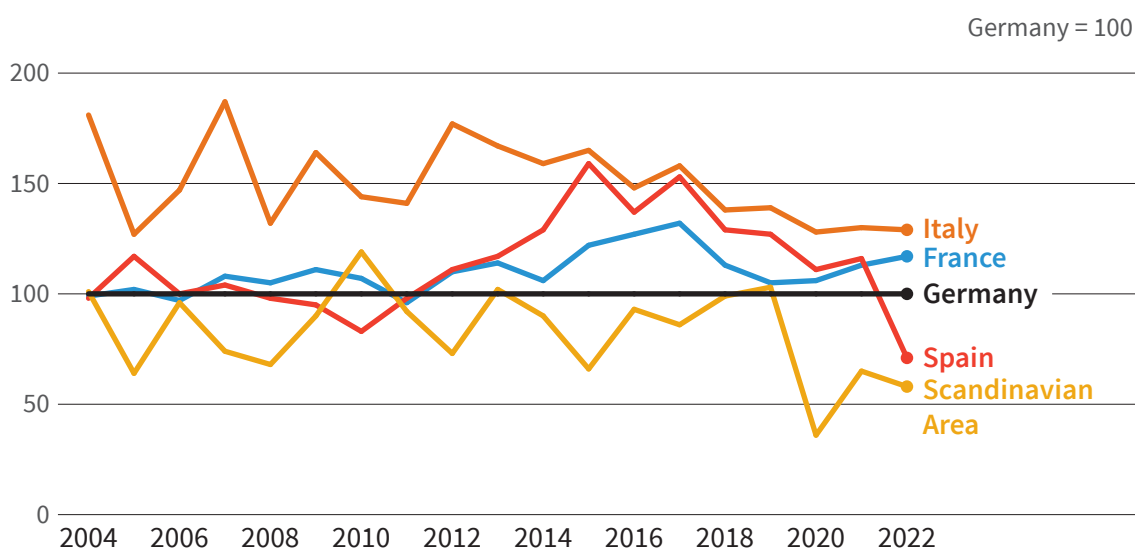
PART II

Key reform pathways

4. FROM COMMODITISATION TO COMMUNITISATION

In the old days of vertically integrated monopolies, electricity was considered an indivisible public service. Liberalisation proved that this service could be divided into several products, each subject to different regulatory and market disciplines. Wholesale spot electricity trading was organised analogously to exchanges used for other commodities⁷⁸. Since the 1990s, financial contracts for electricity (e.g., forwards, futures, and options) have been introduced in most electricity markets, albeit with varying intensity from country to country. As electricity trading requires an underlying electricity transmission network, and as the existing EU transmission networks have several missing links, thus creating multiple bottlenecks, both at and within national borders, price convergence across Europe has not materialised, as shown in the next figure. This figure compares wholesale electricity prices in Italy, France, Spain and the Scandinavian area with Germany, between 2004 and 2022, taking the German price as a reference (one hundred) every year⁷⁹. The amplitude and persistence of price differentials over almost two decades reveals the structural lack of electricity transmission capacity at the core of the EU's interconnected electricity system.

Figure 16 | **Wholesale electricity prices in several countries compared to Germany**



Source: GME

Transmission/transport (and storage) capacity is critical to the efficient trading of any commodity. A lack of capacity leads to excessive price volatility, as is well known in different markets and was clearly observed, for example, on 20 April 2020, when

⁷⁸ Commodity: a good “that is subject to ready exchange or exploitation within a market” <https://www.merriam-webster.com/dictionary/commodity>

⁷⁹ Own elaboration based on GME <https://www.mercatoelettrico.org/En/Statistiche/ME/BorseEuropee.aspx>

WTI crude oil futures traded negatively at USD -37.63⁸⁰. The problem with EU electricity is that, unlike oil and other commodity markets, transmission is a regulated activity, and regulation has been unresponsive to wholesale price signals (see chart above) – as well as to security of supply concerns... Electricity commoditisation and the associated internal electricity market could not be fully accomplished because structural electricity transport restrictions are an obstacle to efficient trading and lead to increasing congestion costs. It is now too late to fix this failure, for the simple reason that, to a large extent, commoditisation will necessarily be replaced by communitisation.

“A large majority of European citizens live in an urban environment, with over 60 % living in urban areas of over 10 000 inhabitants.”⁸¹ The decarbonisation of urban mobility and heating and cooling in buildings, which are among the largest greenhouse gas emitters, is taking place through electrification – electric vehicles and heat pumps. The electrification of road transport and the energy demand of household and services will be responsible for a significant increase in the EU’s total electricity demand compared to current levels.

At the same time, the development of photovoltaic electricity generation in the EU is taking place mainly at the local level, with more than 60% of the total installed photovoltaic capacity coming from rooftop installations. Rooftop generation will not be sufficient⁸², but it is necessary from both an economic and an environmental point of view.

The combination of the three factors mentioned above – the decentralisation of electricity generation resources, the massive electrification of urban energy demand and the persistent lack of transmission capacity – leads to the logical conclusion that urban areas, i.e., local communities, are where the success or failure of the energy transition will be decided. Managing this challenge requires appropriate political and political economy answers, as well as citizen engagement and technical skills.

The speed of deployment of rooftop solar panels and EV charging stations depends on local policies and regulations; the expansion of electricity distribution networks usually depends on municipal concessions and local regulations; decentralised energy resources require decentralised management strategies, local platforms and local governance, which vary from community to community. If municipalities and local communities are unsympathetic – or indifferent - to the energy transition process, the energy transition will not happen. **The commitment of municipalities and local communities is a prerequisite for a successful, cost-efficient energy transition. Moreover, energy communitisation is a very effective way of ensuring that**

80 “It is “conceivable” that a fall to negative prices could happen again, he [Marshall Steeves, energy markets analyst at IHS Markit] said, “given the peculiarities of delivery” to the Nymex delivery point at Cushing, Okla., in terms of pipeline and storage capacity. He pointed out that there’s a finite amount of pipeline capacity to transit crude in and out of storage at Cushing.” - <https://www.marketwatch.com/story/oil-prices-went-negative-a-year-ago-heres-what-traders-have-learned-since-11618863839>

81 https://transport.ec.europa.eu/transport-themes/clean-transport-urban-transport/urban-mobility_en

82 “EU rooftops could potentially produce 680 TWh of solar electricity annually (representing 24.4% of current electricity consumption), two thirds of which at a cost lower than the current residential tariffs” – Katalin Bódis et al., *A high-resolution geospatial assessment of the rooftop solar photovoltaic potential in the European Union*, Renewable and Sustainable Energy Reviews, Vol. 114, October 2019, 109309.

the benefits of the energy transition are shared fairly and that energy consumers have access to the cheapest, cleanest, local electricity available.

In the current debate on electricity reform, there is more than just the risk of underestimating the importance of energy communitisation: there is a very real risk of insisting on energy commoditisation, and perversely deciding to double down on this by increasing the financialisation of energy. Some proposals suggest that electricity market reform should be limited to strengthening long-term financial contracts and reducing the excessive, almost exclusive, reliance on spot markets that characterised the first decades of energy liberalisation in Europe. In practice, this means keeping energy resources away from citizens and offering a highly lucrative, low-risk, new business to the financial industry.

Empowering prosumers and empowering local communities should be the top priority of EU and national climate and energy policies: no energy decarbonisation without energy communitisation.

5. FROM A “SINGLE PRICE AND MULTIPLE SUBSIDIES” TO “MULTIPLE PRICES AND NO SUBSIDIES”

In the first decade of electricity liberalisation (1996-2006), total installed electricity generation capacity increased by 126 GW, of which 64 GW from combustible fuel power plants and 42 GW from wind energy, the latter with a guaranteed sales price – i.e., some form of subsidy. In 1996, installed wind and solar capacity (3.1 GW) represented only 0.6% of total installed electricity generation capacity (567 GW); in 2006, installed wind and solar capacity (48.8 GW) represented 7% of total installed electricity generation capacity (693 GW); in 2020, installed wind and solar capacity (313 GW) represented 33% of total installed electricity generation capacity (962 GW).⁸³ In 2020, subsidies for renewable energy sources in the EU-27 amounted to 80 bn euro⁸⁴. In recent years, many non-renewable electricity generators have started to be remunerated for their installed capacity through various “capacity mechanisms”⁸⁵.

Some Member States have also systematically subsidised large electricity consumers, either directly or through cross-subsidies, creating significant distortions in several industrial sectors, as explained by the Belgian energy regulator in the presentation of the 2022 edition of an annual study comparing the situation in Belgium, the Netherlands, France, Germany and UK:

“All countries, with the exception of the United Kingdom, grant reductions to electro-intensive companies. In Belgium, exemption from the new special excise duty has been possible since this year. Nevertheless, the potential reductions granted in the Netherlands, Germany and France are greater, so the cost of electricity is generally higher for electro-intensive companies in Brussels and Wallonia.”⁸⁶

In 2021 and 2022, subsidies for energy suppliers and energy consumers exploded. According to think-tank Bruegel⁸⁷, between the start of the energy crisis in September 2021 and January 2023, 646 bn euro has been allocated and earmarked across European countries to shield consumers from rising energy costs. In Germany, these subsidies represent 7.4% of GDP, in Italy 5.2%, in France 3.7%, in Spain 3.4% and in Poland 2.2%, to name just the most populous Member States. Not everybody agrees with this excessive *largesse*: “Europe should not be spending billions on subsidies for fossil fuel consumption but be focusing instead on reducing demand and the transition to renewables, according to leading European industrialists.”⁸⁸

83 European Commission, *Energy statistical country datasheets* (last update 17.08.2022)

84 European Commission, *Study on energy subsidies and other government interventions in the European Union – 2022 edition*, Final Report, 2022. Pg. 36 and 50.

85 “Capacity mechanisms are temporary support measures that EU countries can introduce to remunerate power plants for medium and long-term security of electricity supply” – European Commission, https://energy.ec.europa.eu/topics/markets-and-consumers/capacity-mechanisms_en

86 CREG, *A European comparison of electricity and natural gas prices for residential, small professional and large industrial consumers-2022*, <https://www.creg.be/fr/publications/etude-f20220513> (my translation)

87 Bruegel, *National fiscal policy responses to the energy crisis*, <https://www.bruegel.org/dataset/national-policies-shield-consumers-rising-energy-prices>

88 Financial Times, *European industrialists question focus of energy subsidies*, March 5, 2023.

The ideal of a “single market” for electricity has never been fully achieved, mainly because several Member States have refused or delayed the necessary expansion of electricity transmission networks (and the introduction of proper EU operational and regulatory governance). The result is persistent price differentials (see previous chapter) and increasing amounts of “congestion rents” which are a form of cross-subsidy between bidding zones. The very persistence of “bidding zones”, i.e., fragmented network and market areas, is a certificate of non-existence for the single electricity market. The relentless focus on finding ways to keep separate zones together, redrawing zone boundaries and avoiding obscene congestion rents, rather than increasing network capacity, reveals this fundamental political failure.

For the reasons briefly described in the previous paragraphs, reality is increasingly far away from the ideal of a subsidy-free “single market” converging towards a single wholesale electricity price across the EU. In fact, while a formal “single market” organisation has been kept alive, individual Member States have systematically increased the number and volume of national electricity subsidies, distorting not only the European electricity market, but also several manufacturing sectors, notably electro-intensive industries.

While removal and, where appropriate, harmonisation of electricity subsidies should - and can - be actively pursued, the prospects for convergence of national wholesale electricity prices towards a single European wholesale price are unlikely to improve in the near future, given the continuing difficulties in developing electricity transmission networks. Furthermore, the ongoing decentralisation of energy resources, whether concentrated in urban areas or in offshore energy farms, requires the introduction of multiple market platforms, well adapted to different local resources, including networks, and associated (generation and demand) patterns.

Decentralisation accentuates the differences between regions within each Member State, reinforcing pre-existing (in the case of urban areas) or new (offshore) physical “clustering”, amplifying flows within each local “cluster” (platform) and loosening and reversing flows between “clusters”. The pursuit of a single wholesale electricity price in Europe could only be justified if the possibility of massive and rapid reinforcements of both internal “inter-cluster” lines within Member States and cross-border lines between Member States could be considered a realistic scenario. Unfortunately, this possibility is even more utopian today than it was thirty years ago. It is therefore a multiple mistake to aim a single electricity price today; it is more than a mistake, it is blatant hypocrisy, if current multiple subsidies are tolerated.

Promoting efficient competition in electricity today means supporting multiple market platforms and removing all kinds of distorting subsidies.

6. DECENTRALISE THE CENTRALISED, CENTRALISE THE DECENTRALISED

The Single European Act of 1987⁸⁹ defined the internal market as follows (Article 8a EEC Treaty): “The internal market shall comprise an area without internal frontiers in which the free movement of goods, persons, services and capital is ensured in accordance with the provisions of this Treaty.” This implied tax harmonisation (Article 99) and strengthening “the scientific and technological basis of European industry and to encourage it to become more competitive at international level.” (Article 130f); moreover (Article 130b), “[t]he implementation of the common policies and of the internal market shall take into account the [regional cohesion] objectives (...) and shall contribute to their achievement.”

At the heart of the Internal Market are the “four freedoms”: the free movement of goods, persons, services and capital. This requires a certain degree of harmonisation, and, besides ensuring freedom, the Internal Market should also promote innovation and regional cohesion, enhancing competitiveness. Nowhere in the Single European Act is there any mention of centralised markets or centralising infrastructures. Indeed, neither “infrastructure” nor “network”, nor “market operator” or similar expressions appear in the text.

However, it is quite obvious that “free movement of goods” through networks, like electricity or railways, requires more than just fiscal harmonisation – harmonisation must be extended to technical and regulatory spaces, otherwise the goods can’t move physically... It is also clear that, once a minimum level of hardware and software harmonisation has been achieved to allow the physical movement of goods across borders, a certain degree of operational coordination is necessary and a certain degree of planning and investment coordination is desirable to optimise such transactions from technical, environmental and economic perspectives.

Electricity networks cannot support all intended economic transactions because the transmission lines have a finite capacity, which may require some degree of rationing or “redispatching”; moreover, ensuring system stability may require the imposition of other operational restrictions, such as curtailment of generation or shedding of some demand. This requires permanent coordination between economic and physical transactions, i.e., between the entities in charge of economic coordination (market operator) and technical coordination (system operator), regardless of the market model in place.

Optimal technical coordination of any interconnected infrastructure requires the ability to simulate the behaviour of the entire infrastructure; the most efficient way to achieve this goal is through a centralised computer system and a full data set. Any other solution, relying on distributed computation and partial data sets, is sub-optimal and leads to inefficiencies in the use of the available infrastructure and of the available resources connected to it.

89 Official Journal of the European Communities No. L/169 of 29.6.1987 https://eur-lex.europa.eu/resource.html?uri=cellar:a519205f-924a-4978-96a2-b9af8a598b85.0004.02/DOC_1&format=PDF

An efficient Internal Electricity Market requires a European Independent System Operator in charge of monitoring and coordinating the technical operation of the whole interconnected system – regardless of national borders, ownership of network assets and market models. Although this need is widely recognised, there is a lack of political will and readiness on the part of transmission system operators to set up the European Independent System Operator.

A similar difficulty in centralising the operation of network infrastructures can be observed in air transport: “The single European sky (SES) initiative was launched in 1999 to improve the performance of air traffic management (ATM) and air navigation services (ANS) through better integration of European airspace. The stated benefits of the SES could potentially be huge: compared with 2004, the SES (upon completion around 2030-2035) could triple airspace capacity, halve the costs of ATM, improve safety tenfold and reduce the environmental impact of aviation by 10%.”⁹⁰ As with electricity, the impressive benefits of centralised coordination are being sacrificed – and have been for decades – to the symbolic magnificence of national governments, national companies, trade unions, etc..

A curious phenomenon can be observed in the Internal Electricity Market (and the same applies to the Internal Gas Market): although the interconnected electricity transmission network has not been sufficiently expanded to facilitate the free movement of electricity and its development has systematically disregarded the need to improve regional cohesion (both imperatives of the Single European Act of 1987), leading to increasing fragmentation into so-called “bidding zones”, and although no European Independent System Operator has been set up to optimise the use of available resources, as straightforward application of the subsidiarity principle requires, many people have dedicated their efforts to building a centralised wholesale electricity market – something not required by the Treaty and in clear contrast to the lack of centralisation at the technical/operational level. Certainly an interesting experiment, but most of the assumptions of the late 1980s/early 1990s are no longer valid. Insisting on keeping the old neoclassical market model is a nostalgic mistake that must be avoided; promoting the centralised model of the 1990s into a centralistic single market, and thus inhibiting any attempt to develop competition outside the centralised market, is a misstep that can’t be afforded if the 2030 goals are to be achieved. As Ludwig von Mises wrote in 1949: “The mathematical description of various states of equilibrium is mere play. The problem is the analysis of the market process.”⁹¹ And the market process clearly points to digitalisation and decentralisation... The gap between the old, centralised model and the new reality of decentralised investment is widening every year; **the transition from centralisation to decentralisation needs to be properly managed.**

Energy decentralisation is happening because individuals, families, businesses and organisations of all kinds are buying, installing and operating new devices that can

90 European Parliament, *Air transport: Single European Sky*, Fact Sheet <https://www.europarl.europa.eu/factsheets/en/sheet/133/air-transport-single-european-sky>

91 Quoted in Israel M. Kirzner, *Entrepreneurial discovery and the competitive market process: an Austrian approach*, *Journal of Economic Literature*, vol. XXXV, March 1997. Pg. 67.

generate and store energy – not just electrical energy, but also thermal energy. Almost all of these devices are connected to the local electricity network and digitally interconnected via local communications networks and the Internet. Increasingly, new models of traditional appliances on sale (air conditioners, washing machines, refrigerators, etc.) also enable their digital interconnection. Digitally interconnected appliances can be remotely monitored and controlled by their owners. In the simplest case, the owner remotely controls each device individually, turning it on or off, or changing its settings at will. However, owners can also do two other things:

- a) Install and run software that coordinates the operation of their appliances, taking into account a large set of variables, including external variables such as instantaneous indoor and outdoor temperatures, weather forecasts, the price of electricity in some organised markets, and so on. These coordination algorithms usually aim to optimise the use of available energy resources according to the needs and preferences of the owner.
- b) Give a third party remote access to some or all of their digitally connected devices. The third party can aggregate appliances from different owners in different ways (geographically, functionally, etc.) and perform different types of optimisation. Different devices can be delegated to different actors: for example, rooftop photovoltaic panels can be shared with a local non-profit energy community, while some end-use appliances can be assigned to an aggregator for demand-side management purposes.

Digital connectivity is universal: for example, a multinational company can remotely control its plants in different countries. Electrical connectivity, however, has a limited radius because electrical networks are not universally interconnected; therefore, the multinational company cannot combine energy resources from plants located on different continents, or even in the same country, but in different (not at all or only loosely interconnected) regions. Even within a large physically interconnected electricity network, such as the European continental network, a certain degree of fragmentation into multiple zones exists because insufficient network capacity between zones limits the amount of electricity that can be traded between them.

The combination of increasing decentralisation of increasingly diverse and powerful hybrid energy resources, down to fractional micro-ownership of some of these assets, and persistent lack of network capacity, makes decentralisation of the old centralised system inevitable. However, **in electricity systems, decentralisation needs some form of centralisation, not only to ensure the integrity and reliability of the whole interconnected system, but also to enable more efficient use of available resources.**

The transition from wild decentralisation (a completely scattered landscape of individually managed resources) to some degree of local centralisation also needs to be properly managed.

Electricity market reform is like digging a tunnel simultaneously from two sides: from one side, the fully centralised model must be partially and gradually decentralised;

from the other side, fully dispersed resources must be partially and gradually centralised into local platforms; until the two processes meet in the middle, some degree of isolation (inefficiency) is inevitable. The ultimate goal should be the creation of an appropriate platform of platforms.

Decentralising the centralised system basically means abolishing *de facto* monopolies in some market and system operation activities, relaxing some of the present unnecessary and counterproductive rigid legal and regulatory constraints. To quote another Ludwig (Mies van der Rohe), less is more.

Centralising decentralised, atomised resources at the local level does not mean replicating the old, centralised model at the local level - such an attempt would inevitably fail. On the other hand, it would be a big mistake to ignore the “market process” that digitalisation has triggered in so many sectors, i.e., the irruption of digital platforms: “Digital platforms are organizational technologies of disaggregation and reaggregation. (...) platforms enable and encourage what would otherwise be inefficiently small transactions”⁹². Digital platforms are here, a concept ready to be adopted as the backbone of local electricity markets.

Digital platforms are usually associated with the idea of “disintermediation”, i.e., “the elimination of an intermediary in a transaction between two parties”⁹³. Although this concept can be *partially* applied to electricity markets, namely to match the bids of sellers and buyers for different products (e.g., generation, storage, demand), it cannot be *fully* implemented because the feasibility of economic transactions must always be checked by the network operator, who is responsible for the integrity, reliability and quality of the system. This is a particular feature of local electricity platforms.

Digital platforms have been built in many places and in many sectors of the economy around the world. Sufficient technical know-how and empirical data are available to inspire either the design of new digital local electricity platforms or the appropriate adaptation of existing general-purpose platforms, taking into account specific local requirements. However, digital platforms are only a means to an end (a given set of goals); they can be a useful tool to efficiently organise energy resources at the local level, but they do not replace the political definition of a local climate and energy policy. It is important to remember that “[t]he social transformations set in motion by digital hyperconnectivity are not preordained by the nature of networked digital technologies themselves; they emerge rather from the ways in which these technologies and the practices that grow up around them are culturally understood, socially organized, legally regulated, and politically contested.”⁹⁴

92 Rogers Brubaker, *Hyperconnectivity and its discontents*, Polity Press, Cambridge, UK, 2023. Pg. 13.

93 <https://www.merriam-webster.com/dictionary/disintermediation>

94 Rogers Brubaker, *Hyperconnectivity and its discontents*, Polity Press, Cambridge, UK, 2023. Pg. 7.

Managing the ongoing, inexorable and irreversible decentralisation of digitalised energy resources, requires a dual approach:

- On the one hand, amending the current legal framework of the Internal Electricity Market, removing unnecessary centralistic rigidity and defining appropriate interfaces between decentralised (urban and offshore) and centralised platforms.
- On the other hand, the active promotion of the development of local platforms, for the efficient integration of all local energy-related systems, based on appropriate competitive mechanisms and fully exploring the benefits of innovation and energy digitalisation.

Integratio

Latin

Noun

integrātiō f (genitive integrātiōnis); third declension

1. renewing, restoring

2. integration⁹⁵

The Latin root of “integration” contains two different meanings, one being “to renew”, “to restore”, the other being the “act of bringing together the parts of a whole”⁹⁶. Over the past decades, the construction of the Internal Electricity Market was based on the urgent need to bring together newly liberalised national markets that would otherwise drift apart, making cross-border trade of electricity elusive. The Internal Electricity Market was the glue that held together novel, immature national markets and the glaze that created the impression of homogeneity and unity.

We are entering a new phase, where the Internal Electricity Market needs to be renewed – not only in the sense of accommodating increasing amounts of renewable energy sources, but more importantly, in terms of the concept itself. Instead of being the glaze that hides dysfunctional diversity and the glue that guarantees a minimum level of interaction by imposing “single rules”, it should be the enzyme, the catalyst, that accelerates the energy metabolism in many energy-related sectors, enabling and sustaining lively diversity, boosting interactions among different modes of managing energy resources.

The Internal Electricity Market, as an integrative platform, does not aim at homogenising the energy space, presenting itself as a monolithic block that absorbs and integrates everything related to electricity, commoditising the electricity product to the limit. On the contrary, as a platform of platforms, the Internal Electricity Market becomes above all a service, facilitating exchanges across geographical areas, applications (i.e., energy uses) and differentiated functional spaces - i.e., it aims to actively promote integration within a polycentric and evolving structure. Integration will not result from the automatic application of an optimisation algorithm blind to the increasing diversity and complexity of energy services; integration will be the unpredictable outcome of multiple types of interactions within and between platforms, involving an increasing number and diversity of agents and products.

⁹⁵ <https://en.wiktionary.org/wiki/integratio>

⁹⁶ https://www.etymonline.com/word/integrate?ref=etymonline_crossreference

7. DEREGULATE THE OVERREGULATED, REGULATE THE UNDERREGULATED

Today, the Internal Energy Market, comprising electricity and natural gas, provides freedom of choice for all energy consumers, freedom to invest in energy assets and freedom of trade throughout the European Union. The concept of the Internal Energy Market was introduced as a consequence of the Single European Act of 1987, i.e., as its specific declination of the Single (or Internal) Market in the field of energy. It was supposed to be operational on 1 January 1993, as were all the measures related to the completion of the Internal Market⁹⁷, but the first energy liberalisation directives were not adopted until 1996 and 1998 for electricity and natural gas respectively.

The late start of the Internal Energy Market compared to other economic sectors was followed by a relatively slow development of its legal and regulatory framework, with successive improvements being approved in 2003, 2009 and 2018/19. A new legislative review of some partial aspects, which is still ongoing, was launched in 2021 and a proposal for electricity market reform was launched in March 2023.

From a formal point of view, the long process of building the Internal Energy Market has been characterised by increasing intricacy: it started with just one 10-pages directive for electricity and another for natural gas; today it encompasses several directives, regulations, and delegated acts for each sector, amounting to hundreds of pages per sector.

From a substantive point of view, this long process has been characterised by conceptual continuity, successively developing, according to its “internal” logic, a certain model first designed in the early 1990s, essentially ignoring the “external” changes that have occurred since then, in particular with regard to energy and climate policy, the promotion of renewable electricity generation and new technical solutions (storage, digitalisation, etc.). This slow, one-way path contrasts sharply with more imaginative developments in other parts of the world, notably the USA and Australia, where different liberalisation models are adapting much faster to changing technical, social and political factors.

The Internal Energy Market represents not only an important benefit for energy consumers, but also an important political building block of the EU. It must therefore be preserved and continuously improved. However, this does not mean leaving the current market model unchanged, as many factors require structural adjustments and it is currently clearly over-regulated.

97 European Commission, *Completing the Internal Market*, White Paper, COM(85) 310 final, 14 June 1985. https://europa.eu/documents/comm/white_papers/pdf/com1985_0310_f_en.pdf

The Internal Electricity Market today: a semi-integrated “single market”

The Internal Market programme was based on the simple idea that “abolition of barriers of all types” (physical, technical, and fiscal), “unifying this market (of 320 million)”⁹⁸ into a Single Market, would create “a more favourable environment for stimulating enterprise, competition and trade”⁹⁹. This belief that the enforcement of EU competition law, backed up by high-level political statements, would be sufficient to create a Single Market, proved to be wrong in almost all sectors. Experience has shown that a certain degree of harmonisation of national rules and the implementation of some common rules are indispensable conditions for the integration of national markets into a Single Market. On top of this, some *ex ante* regulation at EU level is also necessary in network industries, financial services and other sectors regulated by independent national authorities.

The creation of the Internal Energy Market required more than just the removal of barriers to cross-border trade in electricity and gas, as these sectors were still national monopolies, meaning that there was no freedom of trade even within national borders. In Europe, unlike on other continents, the liberalisation of national markets and the liberalisation of cross-border trade started simultaneously, composing a formidable challenge. Without a common blueprint for energy market liberalisation, the risk of parallel and incompatible national developments was very high, and indeed it happened in the late 1990s that incompatible national rules brought cross-border trade to a standstill in some regions for some time.

Even when it became clear that the naïve approach based on competition law and minimalist common rules (in fact more principles than rules) would not deliver the expected results, the EU did not adopt logical remedies – such as adding new and more specific common rules (i.e., establishing a common market design), centralising the coordination of both technical operation and market operation, creating an EU energy regulator, etc.. There were two reasons for this attitude: Member States did not want to transfer competences to the EU level, as a matter of principle, irrespective of valid technical and economic reasons, and agreeing on a common market design became increasingly difficult as Member States started to implement different rules at national and, in some cases, regional level. The Internal Energy Market was then developed along three lines of action:

- Initially, voluntary agreements between the European Commission, national regulatory authorities and industry increasingly coordinated cross-border trade, albeit at sub-optimal levels.
- New packages of EU legislation (directives and regulations) were added, attempting to solve the existing problems through high-level structural measures (e.g., ownership unbundling), without significant success.
- Finally, some coordination problems were solved by technicalities embedded in a rapidly expanding set of guidelines and network codes.

98 Ibid.

99 European Council conclusions of 29/30 March 1985.

More than thirty years after the first proposals for an Internal Energy Market were published, the twin objectives of abolishing national and cross-border monopolies have been achieved and an integrated single market exists for both electricity and natural gas. However, the “pragmatic” approach to integration adopted so far, which has circumvented key coordination, sharing and governance issues through a series of *ad hoc* fixes, has several drawbacks, namely:

- Persistent lack of physical network capacity in many geographical areas.
- Increasingly inefficient use of available resources (networks, generation plants, storage, demand participation, etc.).
- Consolidation of an intergovernmental “integrated” market design based on numerous political compromises and convoluted technical solutions attained through arcane procedures. This setup is not surprisingly averse to rapid adaptation to any changes - in public policy, technical solutions, business models, etc..

The current “single electricity market” is not the result of the top-down implementation of a well-thought-out model, be it a “standard market model” or a model for the efficient coordination of diverse national or regional markets; it is the outcome of successive bottom-up integration steps negotiated over a long period of time by many stakeholders. Integration has been achieved at a cost in terms of efficiency, transparency, and coherence. Taking into account the changing environment (public policies, technical and social trends,...) in which this integrated market operates, the need for not only small incremental improvements, but for fundamental changes in its design and operation, becomes apparent.

The integration of energy markets in the EU can be achieved and managed in many ways. The current setup and the associated “market model” are the result of contingent political conditions, namely the political rejection of more efficient, but centralised governance. Moreover, the level of energy subsidies, exemptions and special rules introduced by Member States as a response to the 2021/2022 energy price crisis makes the idealised view of the current integrated single market as a level playing field a desolate caricature.

Deregulation of the current single electricity market is an essential condition for the development of truly competitive energy markets, based on large-scale innovation.

The Internal Electricity Market tomorrow: an integrative platform of platforms

The development of distributed, digitalised energy resources within a centralistic regulatory framework is problematic. Some municipalities have actively supported local initiatives but the lack of clarity on so many issues is an obstacle to efficient large-scale decentralisation. Under-regulation is a severe handicap:

Local energy platforms need coherent, suitable regulation that combines rules issued by relevant local and national authorities.

Re-regulation of the Internal Energy Market needs to focus on coordinating a large and growing number of local and offshore platforms. The aim should not be to protect an old model, but to encourage its evolution from a static, centralised and centralistic entity to a dynamic platform of platforms.

8. PHASING IN INNOVATION, PHASING OUT COAL AND GAS ELECTRICITY GENERATION

The four key reform paths described in the previous four chapters address conceptual, institutional and regulatory issues. From a practical, material point of view, electricity reform is about two main, interrelated issues:

- Phasing out coal and natural gas power plants to decarbonise electricity.
- Phasing in not only additional renewable power plants to replace the fossil ones and support electrification of mobility and heating/cooling, but also the enablers of different energy management strategies, such as storage, sensors, meters and control devices.

Only a sensible combination of soft (institutional and regulatory) resources and hardware can ensure an efficient energy transition process.

Phasing-out - two elephants in the room (i.e., two repressed questions...)

As discussed above, from a physical point of view, decarbonisation requires, inter alia:

- Electrification of heating/cooling and transport, leading to an increase in electricity demand of around or more than 100%.
- Increased renewable electricity generation capacity to meet an increase in electricity demand of 100% or more.
- Replacement of fossil fuel electricity generation plants, which represent 40% of the current total installed capacity, with renewable energy power plants.

These physical, quantitative requirements, raise two fundamental financial questions:

- How to remunerate existing fossil fuel generation plants so that they remain online as long as possible but generate as little as possible?
- How to attract private capital to build the necessary additional renewable electricity generation capacity?

The question of how to finance the phase-out of fossil fuel electricity generation plants is the first elephant in the room. *Ad hoc* and uncoordinated solutions have been adopted by some Member States to remunerate this generating capacity. This lack of coordination and transparency has led to two equally dangerous results:

- Significant distortions in European electricity markets (both at national/regional and at EU level), thereby discrediting price signals in the wholesale electricity market.
- Impossibility to carry out consistent and robust security of supply assessments at EU level, thus jeopardising the security and reliability of the interconnected electricity system.

Coordination does not mean full harmonisation, imposing the same methodology and possibly the same targets and the same timetable on all Member States. This

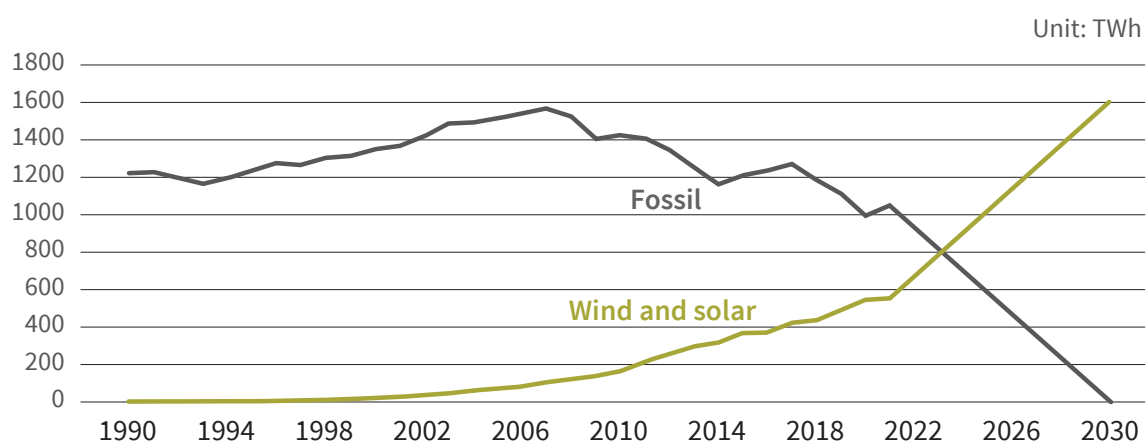
approach would be wrong, as Member States exhibit different starting points (see Figure 5), different decarbonisation strategies and different electricity mixes, and therefore different technical (i.e., control and reliability) requirements. Each Member State will therefore define its own exit strategy, ensuring that it is technically and financially feasible. However, national strategies need to be coordinated at EU level as their externalities - positive or negative - on all other interconnected systems cannot be ignored and this may lead to some adjustments of previously defined national strategies. Coordination will ensure that:

- The reliability of the European interconnected electricity system is guaranteed under all commonly agreed future development scenarios.
- Whenever necessary, coordinated measures are taken to avoid jeopardising system security and stability.
- National financial incentives minimise distortions in the European wholesale electricity market.

Based on Member States' national plans, the EU should establish and monitor the implementation of an "EU plan for the phase-out of fossil fuel-fired electricity generation plants", subject to prior technical consistency analysis. This plan should include yearly targets until at least 2035.

Assuming a linear phase-out of fossil fuel power plants from now until 2030¹⁰⁰, with their generation being taken over by wind and solar sources, the future evolution of electricity generation is described in the next figure (see also Figure 12, Introduction).

Figure 17 | **Evolution of gross electricity generation (decarbonisation) EU, 1990-2030**

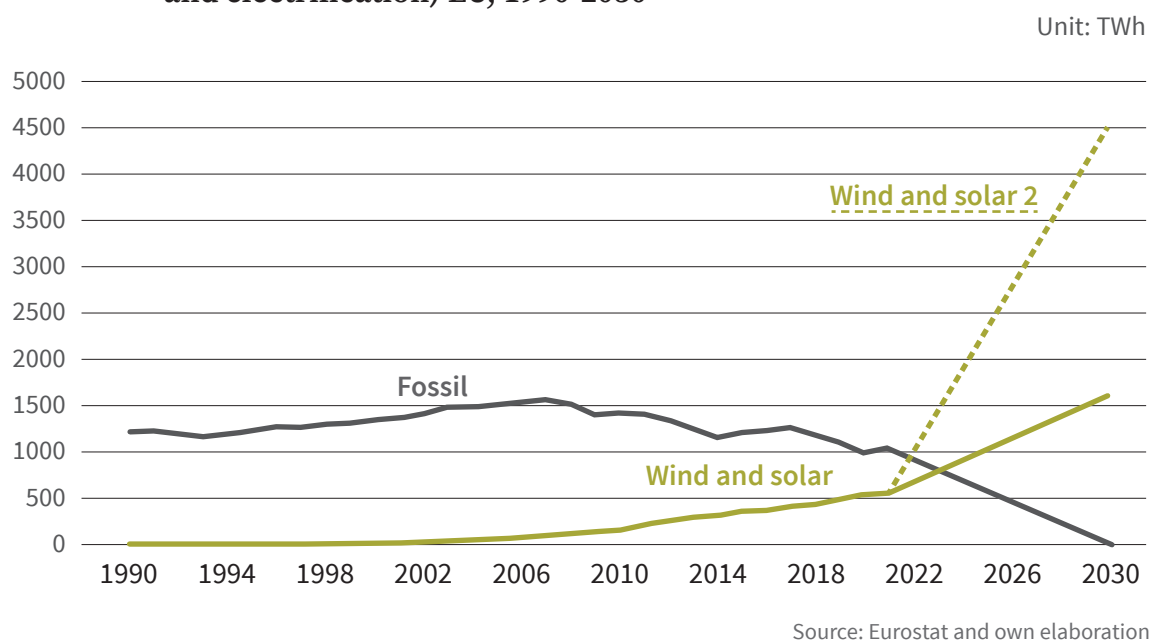


Source: Eurostat and own elaboration

¹⁰⁰ According to the European Commission, "Fit for 55 would lower our gas consumption by 30% by 2030" - Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, REPowerEU Plan, COM(2022) 230 final of 18.05.2022 https://eur-lex.europa.eu/resource.html?uri=cellar:fc930f14-d7ae-11ec-a95f-01aa75ed71a1.0001.02/DOC_1&format=PDF

Assuming that by 2030 total final electricity demand will be twice as high as today, growing linearly, as a result of massive mobility and heating/cooling electrification, with nuclear and hydro maintaining their current levels, the required combined amount of wind and solar generation is shown in the next figure. A structural change of such magnitude requires careful and coordinated analysis at European level.

Figure 18 | **Evolution of gross electricity generation (decarbonisation and electrification) EU, 1990-2030**



The answer to the second question (how to attract private capital to build the necessary, additional renewable electricity generation capacity?) cannot be “through the existing wholesale market” because it did not work in the past (see Introduction, Sections on generation and subsidies) and it cannot work in the future, i.e., in a fully decarbonised system, because there the marginal market price would be near zero or negative most of the time, meaning that investors would not be able to recoup their investments. This is indeed the main reason why electricity market reform is inevitable and has been advocated for many years by a few people, including the authors of this report. There are several answers (besides capacity mechanisms) that can be combined in different proportions: self-generation, corporate PPAs, state-guaranteed and/or managed PPAs, mandatory long-term markets, etc.. All these solutions represent significant changes to the current short-term, energy-only market model and their introduction requires careful consideration.

Today, there is no shortage of private capital willing to invest in new electricity generation projects, either through private or public long-term contracts, but there is a huge scarcity of network connection capacity. **The question about how to expand (transmission and distribution) networks fast enough to accommodate new generation capacity is the second elephant in the room.** As regulated entities, electricity networks depend primarily on regulatory – and political – decisions, not on market

signals. The lack of cross-border interconnection capacity and its consequences are well known: the volume of cross-border electricity trade within the EU, equivalent to circa 11% of final demand, is roughly the same as before liberalisation, taking into account changes in EU's political borders. The lack of available network capacity at national level is also well known: in a growing number of Member States, requests to connect generation to the network amount to many times the existing network capacity... and there is no short-term perspective on how these bottlenecks will be unblocked in a fast and fair way¹⁰¹.

The existing 10-year network development plans (TYNDP)¹⁰², which have been regularly prepared at European level since 2010 on the basis of national development plans and stakeholder input, are useful but still very incomplete tools. In particular, as pointed out by ACER, “[t]he role of DSOs in shaping the energy sector should be considered”¹⁰³ and because “the increased RES integration levels according to the REPowerEU policy update were not considered”, “[t]he Agency considers that the lack of trust in TYNDP 2022 scenario assumptions makes the TYNDP analysis of limited value”¹⁰⁴. These documents, besides revealing the worrying fact “that in 2022, the declining trend of the number of transmission investments and the related costs in the EU TYNDP since 2016 further continues”¹⁰⁵, do not provide “an assessment of whether the investments of the draft EU TYNDP 2022 are sufficient to reach the decarbonisation objectives”¹⁰⁶.

Based on accurate and binding national plans from Member States, the EU should approve and monitor the implementation of the “EU electricity transmission and distribution network development plan”. This plan should include yearly targets until at least 2035 for both transmission and distribution networks, attesting compatibility between network capacity and decarbonisation objectives at national and EU level, as well as the reliability of the European interconnected electricity system. These network capacity targets must be consistent with, and ideally should be part of, National Energy and Climate Plans.

101 The same situation is experienced in the USA, where the federal energy regulator (FERC) has been working on transmission reform for several months - <https://www.federalregister.gov/documents/2022/06/02/2022-11775/building-for-the-future-through-electric-regional-transmission-planning-and-cost-allocation-and>

102 https://tyndp.entsoe.eu/explore#explore__line

103 ACER, Opinion No 03/2023 of the European Union Agency for the Cooperation of Energy Regulators of 4 April 2023 on the methodological aspects of the ENTSO-E draft Ten-Year Network Development Plan 2022

104 Ibid.

105 ACER, Opinion No 04/2023 of the European Union Agency for the Cooperation of Energy Regulators of 4 April 2023 on electricity projects in the draft ENTSO-E Ten-Year Network Development Plan 2022 and in the National Development Plans

106 Ibid.

Phasing-in

There is a third elephant in the room: full decarbonisation cannot be achieved by “more of the same”, i.e., more wind and solar PV generation capacity alone (see Figure 18), without massive deployment of storage and digitalisation. However, current market models and regulatory frameworks are not conducive to the large-scale deployment of storage and other new, clean technical solutions.

EU rules on the treatment of both centralised and decentralised, short-term and long-term storage, should be urgently adopted to encourage the rapid deployment of electrical and thermal storage and their integration into local energy platforms.

The digitalisation of energy is an essential prerequisite for efficient energy decarbonisation. As some economists have recently pointed out, “[t]he delay in the diffusion of ICT [Information and Communication Technologies] observed in the electricity sector is due, not to high costs, but rather to the lack of “secondary innovations”. ICT are general purpose technologies, but they are not “ready-to-wear”: “Its implementation in the various sectors of the economy necessitates secondary “process” innovations. Each secondary innovation adapts the GPT [general purpose technology] to the needs of a particular sector.”¹⁰⁷

Innovation requires more than just the production and use of new technical objects or the adoption of new technical processes, it requires a new idea of how to organise these novelties: “the industry is first and foremost a community of work organised and oriented by a shared imaginary to produce, and not a set of techniques implemented.”¹⁰⁸

The digitalisation of energy is taking place in several segments: end-use energy management, substation automation, metering, system control, etc.. However, a comprehensive approach – a “secondary process innovation” blueprint for the electricity sector as a whole – is still lacking. This absence not only causes delays, but also a number of inefficiencies. Different national standards and requirements, not justified by any technical or economic criteria, contribute to fragmentation, delays and overall inefficiency.

In the 1980s, a pan-European mobile technology was developed based upon the initiative of the Confederation of European Posts and Telecommunications. In 1986, the GSM project was endorsed by the EU and in 1987, 13 European countries committed to deploy GSM. Deployment began in 1991 and by 1997 100 countries had adopted GSM networks ¹⁰⁹. This success story could inspire a similar approach to energy digitalisa-

¹⁰⁷ Philippe Aghion, Céline Antonin and Simon Bunel, *The power of creative destruction*, The Belknap Press of Harvard University Press, 2021. Pg. 42.

¹⁰⁸ Pierre Musso, *Qu'est-ce que l'industrie ? Une approche philosophique*, Éditions Manucius, Paris, 2022. Pg. 22. En fait l'industrie est d'abord une communauté de travail organisé et orienté par un imaginaire partagé pour produire, et non un ensemble de techniques mises en œuvre.

¹⁰⁹ <https://www.gsma.com/aboutus/who-we-are/our-history/>

tion, to the benefit not only of European energy users, but also of European industry.

Energy digitalisation is neither a “natural” nor a “neutral” process. It has serious economic and political implications that go far beyond the limited horizons of the cost-benefit analysis currently undertaken by EU Member States. If properly managed, this process can bring substantial advantages to energy users all over the world. **Managing energy digitalisation essentially means choosing between two alternative approaches: a citizen-centred path that empowers consumers, reduces industry concentration and democratises energy resources, or a self-referential industry approach that reinforces technocratic dominance over energy resources.** Energy digitalisation is a big opportunity, but... “Although general-purpose technologies [such as electricity or computers] can be developed in many different ways, once a shared vision locks in a specific direction, it becomes difficult for people to break out of its hold and explore different trajectories that might be socially more beneficial. Most people affected by those decisions are not consulted.”¹¹⁰

The EU should implement a citizen-centred energy digitalisation strategy based on appropriate standards and rules that promote energy system integration and interoperability between different segments of the electricity value chain.

¹¹⁰ Daron Acemoglu and Simon Johnson, *Power and progress*, Basic books, UK, 2023. Pg. 27.

PART III

The local perspective

9. DECENTRALISATION AND COMPETITIVE LOCAL PLATFORMS

“Cities have been invented several times quite independently, and the results have been surprisingly similar. (...) Some cities show a high degree of planning. Others seems to have emerged organically as a product of many convergent patterns of change. The selective pressures don’t care whether the variation was driven by genes or generals.”

Greg Woolf¹¹¹

Urban areas are home to 75% of EU citizens, up from 59% in 1960¹¹², and they have been relentlessly reinvented. Climate policy is now challenging EU cities - and they are adapting to the new “selective pressures”. Some “patterns of change” are already visible, such as:

- The growing number of bicycles and the increasing length and quality of cycling road networks, both within and between cities¹¹³.
- The growing number of vehicles available through commercial and sharing platforms (cars, e-scooters, mopeds, bicycles, etc.).
- The fast-growing number of solar rooftop plants: “Rooftop solar added 25 GW in 2022, 8 GW more than in 2021. There was a strong increase on the residential and small commercial segment, as such investment decisions can be quickly made, and such small systems sizes rather quickly built. (...) When looking at cumulative installed capacities, rooftop PV represents 66% of the 209 GW installed across the EU at the end of 2022. With the slower than earlier expected increase of large-scale solar, the total rooftop share is expected to decrease only slightly to 59% by 2026.”¹¹⁴

According to a 2019 report by the EU’s Joint Research Centre, “EU rooftops could potentially produce 680 TWh of solar electricity annually (representing 24.4% of current electricity consumption), two thirds of which at a cost lower than the current residential tariffs.”¹¹⁵

- The growing number of electric vehicle charging points: with electrically powered vehicles currently accounting for almost 20% of new car sales in the EU, wallboxes are increasingly populating EU homes and buildings. In fact, the growth of charging points is lagging behind the growth of electric vehicles, as shown in the next figure¹¹⁶.

111 Greg Woolf, *The life and death of ancient cities*, Oxford University Press, 2020. Pgs. xii and xv.

112 World Bank, <https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=EU>

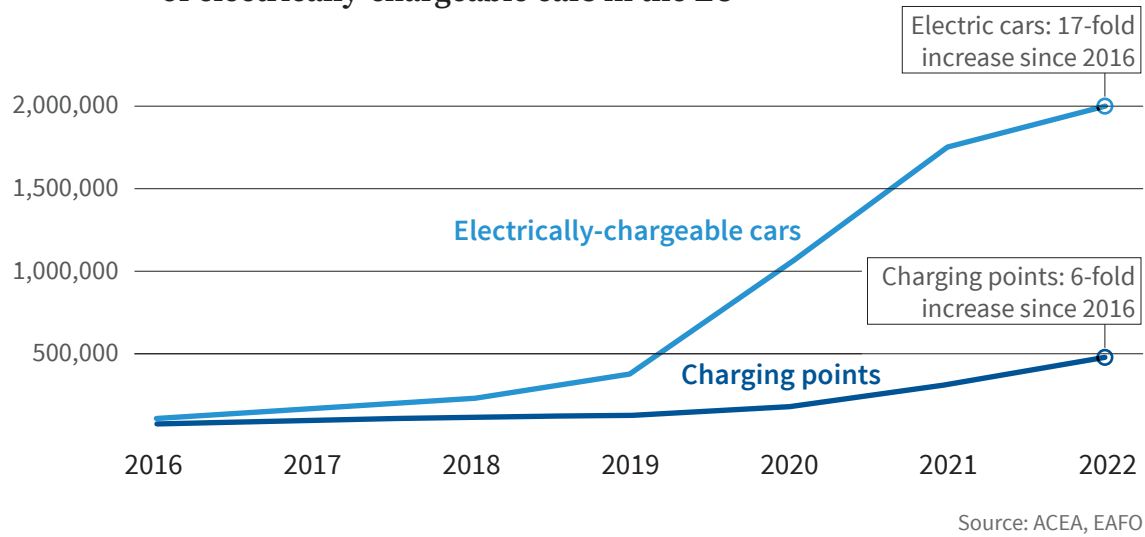
113 In 2021, more than 5 million electric bicycles were sold in the EU (<https://www.statista.com/statistics/397765/electric-bicycle-sales-in-the-european-union-eu/>), while total EU bicycle production reached 13.5 million units (<https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20220912-2>).

114 Solar Power Europe, *EU Market Outlook For Solar Power 2022 – 2026*. 19.12.2022. <https://www.solarpowereurope.org/insights/market-outlooks/eu-market-outlook-for-solar-power-2022-2026-2#downloadForm>

115 Katalin Bódis et al., *A high-resolution geospatial assessment of the rooftop solar photovoltaic potential in the European Union*, Renewable and Sustainable Energy Reviews 114 (2019) 109309 <https://doi.org/10.1016/j.rser.2019.109309>

116 ACEA <https://www.acea.auto/figure/charging-point-deployment-versus-sales-of-electrically-chargeable-cars/>

Figure 19 | **Charging points deployment versus sales of electrically-chargeable cars in the EU**



“In 2021, the continent had an estimated 375,000 charging stations. But a recent analysis by McKinsey (...), conducted for a report from the European Automobile Manufacturers’ Association (ACEA), suggests that - in even the most conservative scenario - the EU-27 will need at least 3.4 million operational public charging points by 2030”¹¹⁷; this implies “an acceleration from about 1,600 installations of public charging points a week in 2021 to more than 10,000 a week in 2030” and an increase of (renewable) electricity demand from electric-vehicle charging from 9 TWh in 2021 to 165 TWh in 2030¹¹⁸.

- The increasing number of electric cars on the road, as shown in the figure below¹¹⁹. In 2021, electrically-chargeable vehicles accounted for 18.0% of total car registrations, up from a 10.5% share in 2020 and just 1.9% in 2018¹²⁰.

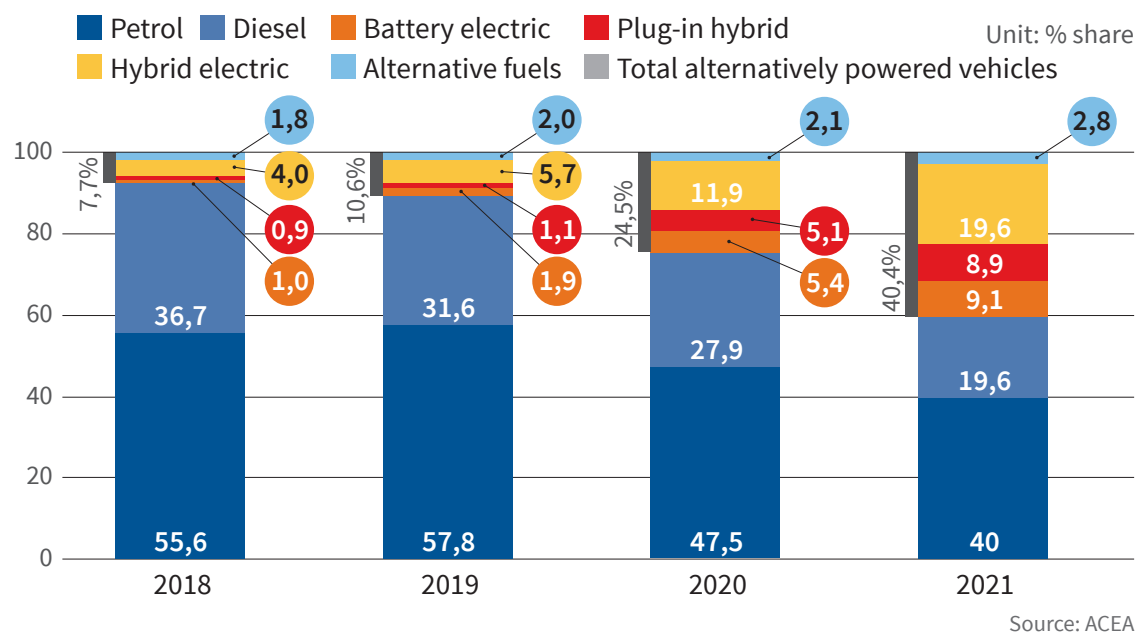
¹¹⁷ Julian Conzade et al., *Europe’s EV opportunity—and the charging infrastructure needed to meet it*, McKinsey Article, 04.11.2022, <https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/europes-ev-opportunity-and-the-charging-infrastructure-needed-to-meet-it>

¹¹⁸ Ibid.

¹¹⁹ ACEA <https://www.acea.auto/files/fuel-types-of-new-passenger-cars-in-eu-2022-1024x576.png>

¹²⁰ This share keeps growing: in 2022 it reached 21.5 % (https://www.acea.auto/files/20230201_PRPC-fuel_Q4-2022_FINAL-1.pdf)

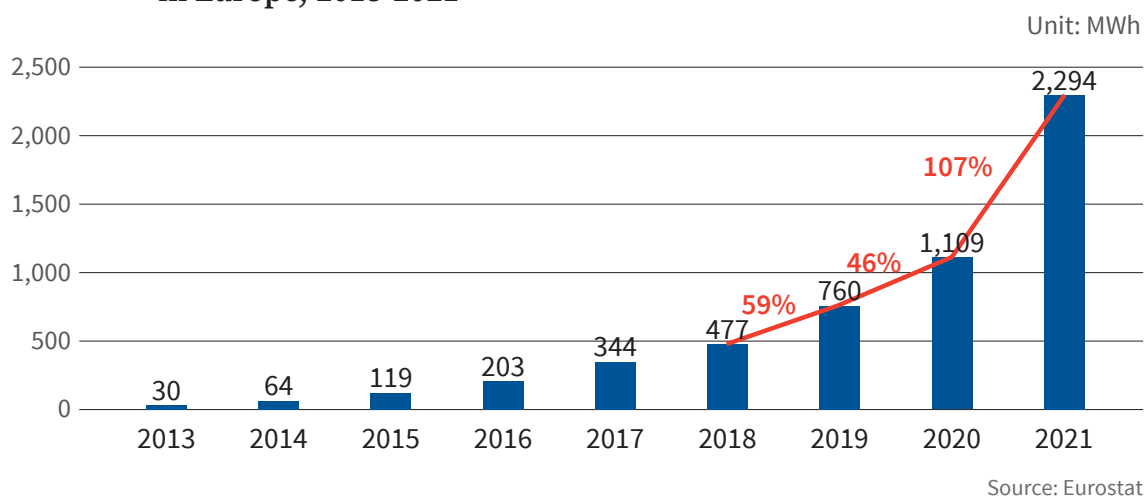
Figure 20 | Yearly sales of new cars in the EU by fuel type, 2018-2021



Other developments are less visible from city streets, but equally transformative for urban energy patterns, such as:

- The increasing number of batteries in homes: a recent report estimates that “Europe will install over 420,000 storage batteries in 2022, resulting in more than 1 million homes across the continent powered with joint solar & battery storage systems. It could have been much more, but a lack of installers across Europe limited the growth of solar systems.”¹²¹ Sales of residential battery energy storage systems is growing very fast, as shown in the next figure¹²².

Figure 21 | Yearly sales of residential battery energy storage systems in Europe, 2013-2021

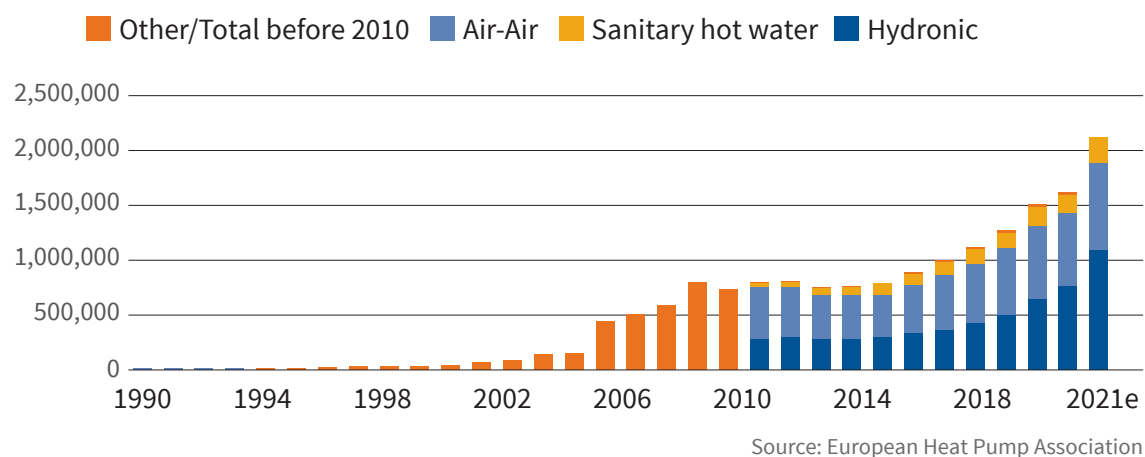


¹²¹ Solar Power Europe, *European Market Outlook For Residential Battery Storage 2022–2026*, December 2022. <https://www.solarpowereurope.org/insights/thematic-reports/european-market-outlook-for-residential-battery-storage-1>

¹²² Ibid.

- The growing number of heat pumps installed in buildings, as shown in the next figure¹²³, with a current installed stock of 15 million, representing more than 10% of European households¹²⁴. By the end of 2021, the total installed capacity of heat pumps in the EU-27 has reached 290 GW¹²⁵.

Figure 22 | **Yearly sales of heat pumps in Europe, 1990-2021**



Today, purchasers of solar photovoltaic systems, batteries, heat pumps and electric vehicles, all receive free software to monitor and control their performance. Some equipment suppliers even provide their customers with software tools that allow them to jointly monitor and control equipment from different categories and manufacturers. Moreover, some software providers and utilities sell applications that integrate multiple devices into a single HEMS (Home Energy Management System), thus allowing users to optimise the use of their energy resources. In other words, millions of “mini local platforms” have already been installed across Europe.

EMS (Energy Management Systems) used to be complex and expensive software tools for energy professionals in charge of day-to-day management of energy resources and demand in large industrial or commercial sites. Today, they are just another app on our smartphones, enabling citizens to manage energy in their homes and vehicles, and small and medium enterprises to manage energy in their businesses.

Energy decentralisation is a new reality – not only because energy resources and devices are increasingly decentralised, in a geographical sense, but also because these resources and devices are increasingly controlled locally by their owners, either directly or through local communities. The existing “mini local platforms” can easily be combined into “local community platforms” that manage energy resources in apartment buildings, shopping centres, etc., as several examples around the world clearly show. The range of “local community platforms” can easily be extended to include neighbours in different buildings and in different streets. These “local community

¹²³ European Heat Pump Association, <https://www.ehpa.org/market-data/>

¹²⁴ <https://www.rehva.eu/rehva-journal/chapter/european-heat-pump-market>

¹²⁵ Eurostat, https://ec.europa.eu/eurostat/databrowser/view/NRG_INF_HPTC__custom_6328540/default/table?lang=en

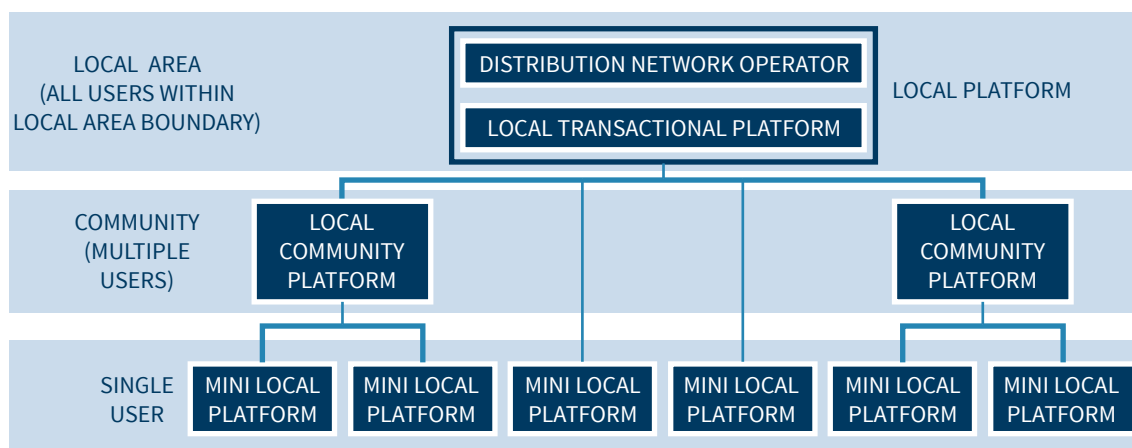
platforms” can be non-profit entities such as cooperatives, a set of different facilities from the same owner, for-profit local organisations, local branches of larger energy supply or service organisations, etc..

Mini-local platforms usually aim to minimise energy costs for users. When decarbonisation is considered, minimising greenhouse gas emissions may be an alternative criterion. Local community platforms may also aim to minimise costs for users (if non-profit) or to maximise benefits (if for-profit). In any case, users are mainly concerned with “their” own resources: external energy resources are seen as top-ups, and/or back-ups to their own sources, or as sunk for their excess generation; external distribution networks are usually not considered at this level of energy management, except as a “tariff variable” to be included in the financial equation.

When multiple “local community platforms” operate within a given geographical area, they cannot ignore the physical reality of the local distribution network, as network constraints may limit their transactional freedom. The same applies to individuals and their “mini local platforms”: for example, access to a cheap surplus of PV electricity generation may be limited to some users in a given street due to capacity restrictions in the feeder connecting them to the nearby electrical transformer. Therefore, a local entity is needed to help manage potential or actual conflicting interests; this entity - called the “local transactional platform” for convenience - must be responsible for the transactional space i.e., the set of all transactions among different resources involving use of public networks and affecting overall reliability and quality of service.

While the responsibility for the operation of the distribution network is assigned by law to the distribution network operator, the responsibility for “the other side of the coin”, i.e., the management of the local transactional platform, can be assigned to different bodies. Conceptually and institutionally, the local conflict-solving entity may be two different organisations - similar to what happens at national level, where “market operator(s)” and “transmission network operator” interact to perform this function – or only one. Furthermore, each local platform operating within the boundaries of its local area may wish to interact with similar platforms in other areas, as shown in the next figure.

Figure 23 | **Different energy management platforms at local level**



Today, each local area contains significant amounts of both generation and demand - and, increasingly, storage. In the past, local generation was negligible and electricity flows were always inwards; today, flows alternate in both directions, inwards and outwards, with an increasing number of local areas becoming net “exporters” of electricity over daily, monthly or annual time periods.

Within national electricity systems, electrical boundaries cross “critical circuit paths that carry power between the areas where power flow limitations may be encountered” ¹²⁶, and thus define several “clusters”, or “zones”, i.e., areas with a relatively homogeneous internal flow density, as compared to flows to/from adjacent areas. These notional boundaries split the national electricity system into two or more parts. Electrical boundaries can be removed if and when sufficient investment is made to expand networks, and they can also change with time, whenever generation and/or demand patterns change significantly.

The digitalisation of energy provides incredible power to all these energy management platforms, enabling fast and targeted control (manual, automatic or hybrid) of all connected devices and systems. It also allows the selective assignment of control functions to different levels, the adoption of differentiated control strategies over space and time, etc.. In addition, continuous improvements in power electronics are transforming hitherto passive elements (namely those associated with DC/AC inverters, such as solar panels and batteries) into active participants in energy management.

The extraordinary plasticity introduced by both power electronics and energy digitalisation in general supports innovation and competition in energy management systems. If properly framed in each local area, under the operational supervision of the local platform and appropriate regulation, this plasticity can enhance technical and economic efficiency. In this context, the concept of competition is much broader than just price competition in traditional electricity markets and includes the following aspects, among others:

- Competition between software providers of “mini local platforms”.
- Competition between software providers of “local community platforms”.
- Competition between software providers of “local platforms”.
- Competition between operators of “local community platforms”.
- Competition between operators of general purpose “local community platforms” and operators of special purpose “local community platforms”, such as dedicated platforms for EV charging.
- Competition between operators of “local community platforms” and traditional electricity suppliers.

Moreover, plasticity can be used to modulate the speed of energy transition processes, according to public policy goals and to the speed of infrastructure modernisation and expansion in each area, allowing for progressively greater freedom and

¹²⁶ UK National Grid ESO <https://www.nationalgrideso.com/research-and-publications/electricity-ten-year-statement-etys/etys-and-our-future-network-planning>

creativity in the transactional space. As different cities and metropolitan areas move towards carbon neutrality at different speeds, depending on their respective characteristics and resources, starting point, boundary conditions, public policies, etc., decentralisation avoids the risk that the slowest areas slow down the whole EU transition process.

10. THE INSTITUTIONAL CHALLENGES OF ENERGY SYSTEM INTEGRATION

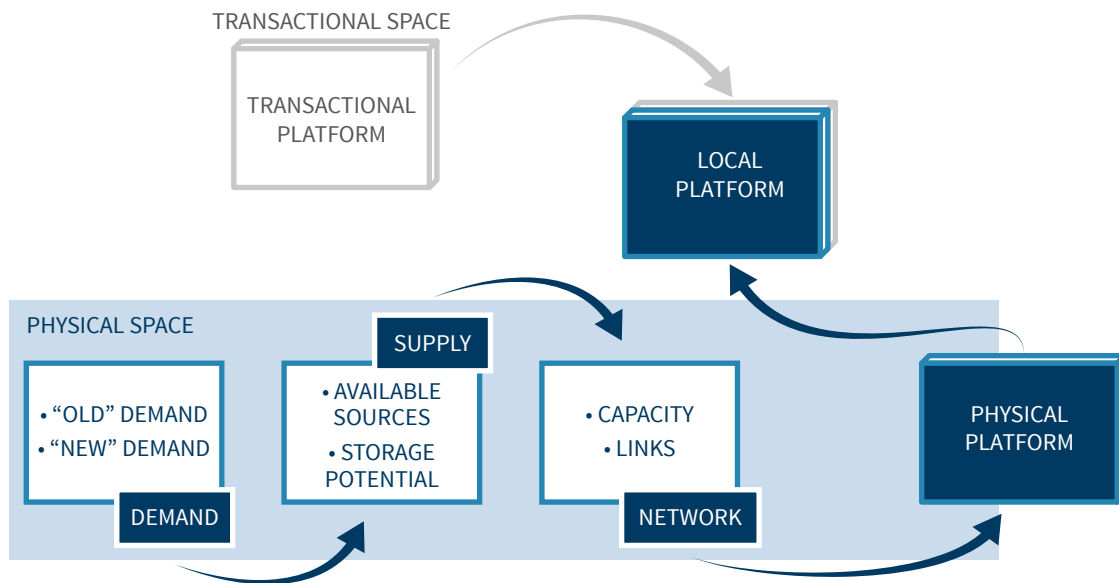
“There is in this new learning of dependence, an opportunity to redefine emancipation and the search for autonomy. The more we depend, the better. But how contrary to our habits, this quest for <links that liberate> ! “

Bruno Latour and Nikolaj Schultz ¹²⁷

The more we know about our planet and how we interact with it, the more we discover the meaning of interdependence and the importance of a sustainable relationship between society and the planet. The way in which energy resources are used plays a very relevant role in this relationship and largely determines its sustainability.

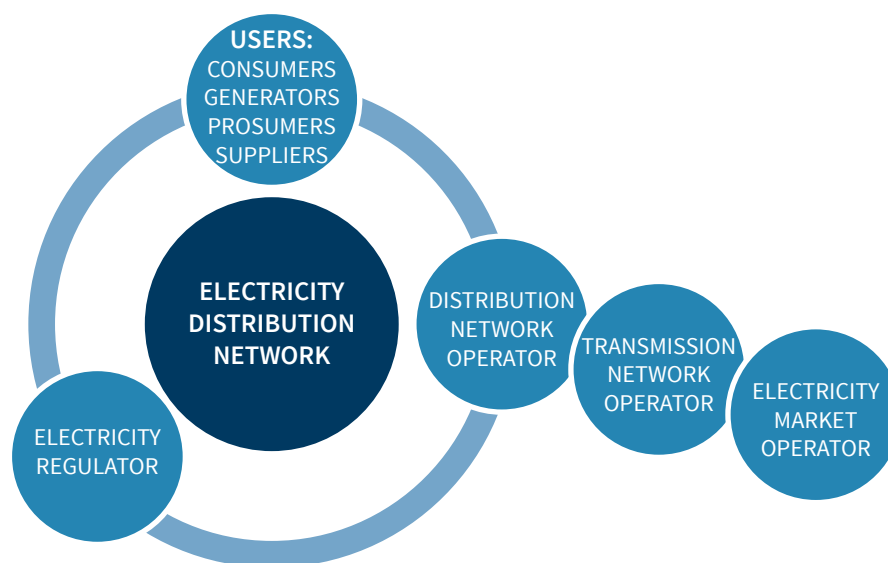
Energy system integration promotes the efficient use of energy resources and the minimisation of greenhouse gas emissions, including through the widespread electrification of several sectors, namely urban mobility and heating and cooling (“new demand”). Based on the analysis of the demand side (“old” and “new” types of demand), the next step is to assess how and to what extent this demand could be matched by locally available energy sources, from a conceptual energy balance point of view. This analysis must systematically include all possibilities for avoiding energy demand in the first place (e.g., through more efficient buildings, more public transport, etc.) and also for reusing energy (e.g., avoiding heat waste). The next step is to assess whether the existing infrastructures (namely, electricity distribution networks) would be able to support the energy transits associated with this conceptual match between local demand and local resources, identifying missing links and missing network capacities. Once the physical analysis has been completed and the shape of the physical platform has been determined, the next step is to discuss how to organise the transactional platform(s) serving local users and compatible with the physical platform – the physical and transactional domains being the two sides of the same coin. The specification of the transactional platform includes not only a definition of the different types of permitted transactions, the actors involved and their respective duties and rights, but also a description of the information and communication infrastructure required to support these transactions and to interface with the electricity network operator’s own information and communication system. This completes the high-level hardware design of the local energy platform – see next figure.

¹²⁷ Bruno Latour and Nikolaj Schultz, *Mémo sur la nouvelle classe écologique*, Éditions La Découverte, Paris, 2022. Pg. 43. Il y a dans ce nouvel apprentissage de la dépendance, une occasion de redéfinir l’émancipation et la recherche d’autonomie. Plus nous dépendons, mieux c’est. Mais comme elle est contraire à nos habitudes, cette quête des <liens qui libèrent> !

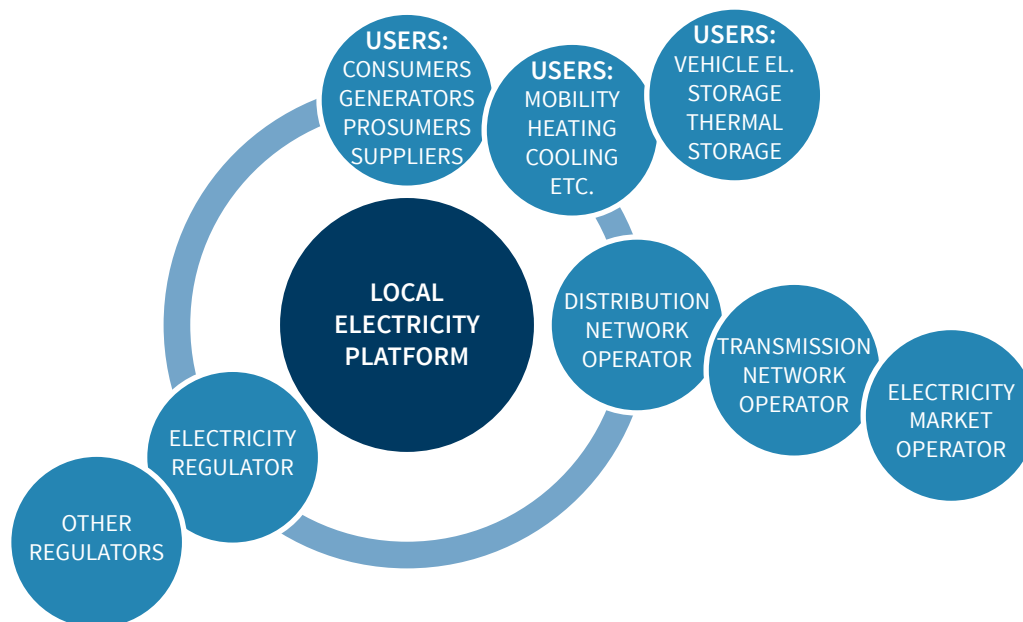
Figure 24 | **Local energy platform – basic design process**

Regardless of their degree of integration, energy systems need to be operated and properly managed. The electricity platform, as the pivot of the integrated energy system, plays a key role and its operation must reflect its new function and statute. The technical rules followed by the electricity platform must be consistent with the physical behaviour of electricity systems, but they must also be coherent with the purpose of an integrated energy system and with the transactional rules that materialise such an integrative approach. This requires a suitable governance model involving all relevant stakeholders.

Electricity distribution networks have traditionally been considered as natural monopolies subject to specific regulation. Their evolution was the result of a process of multiple interactions between network users, the network operator and the electricity regulator, as described in the next figure. The distribution network operator also interacted with the transmission network operator, who was responsible for managing the electricity “system” and coordinating with the respective electricity market operator(s).

Figure 25 | **The old electricity distribution network in context**

The evolution from the traditional electricity distribution network to the electricity platform brings into play a whole range of new actors – or new roles for the same actors – as discussed in the following chapter and shown in the next figure.

Figure 26 | **The new local electricity platform in context**

A semantic note is needed at this point. Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU (recast)¹²⁸ uses the word “system” exactly 600 times – and never defines its meaning. EU legislation first introduced

128 OJEU L158 of 14.06.2019

the expressions “distribution system operator” and “transmission system operator” in 2003¹²⁹, without defining “system”¹³⁰. The 2019 Directive retains the 2003 above-mentioned definitions, as well as the definition of “system user” as “a natural or legal person who supplies to, or is supplied by, a transmission system or a distribution system”, first introduced in 1996 by Directive 96/92/EC^{131 132}.

The inflation of the word “system” in EU energy legislative documents has led to an increasing number of meanings being attributed to it, reflecting the legislator’s difficulty in coping with the growing complexity of the Internal Electricity Market. The increase in the complexity of the electricity “system” is both intrinsic and extrinsic, and it has three main origins:

- First, energy digitalisation, energy decentralisation, increasing amounts of storage and other “modern” technical factors inevitably complexify the intrinsic physical behaviour of electricity systems as compared to the “traditional”, “pre-modern” situation, regardless of market models adopted.
- Second, attempts to keep the (centralised) “Single Market” model alive in the face of ongoing structural, physical changes towards decentralisation increasingly require “artificial” interventions in the existing legal and regulatory framework, thus adding new layers of – extrinsic – complexity to the electricity system.
- Finally, energy system integration enlarges the scope of “energy” and thus of the “energy system”.

Talking about energy transition or EU electricity reform requires some “system” clarification... First of all, it’s crucial to acknowledge that the subjacent “energy system” concept encompasses all related energy resources, energy uses and energy infrastructures:

“Today’s energy system is still built on several parallel, vertical energy value chains, which rigidly link specific energy resources with specific end-use sectors. For instance, petroleum products are predominant in the transport sector and as feedstock for industry. Coal and natural gas are mainly used to produce electricity and heating. Electricity and gas networks are planned and managed independently from each other. Market rules are also largely specific to different sectors. This model of separate silos cannot deliver a climate neutral economy. It is technically and economically inefficient and leads to substantial losses in the form of waste heat and low energy efficiency.”¹³³

In the new integrated energy system, the electricity system is a sub-system of the energy system. From both a physical and a transactional perspective, defining the electricity system requires defining both its internal rules and its interfaces with other energy systems. Whenever one of these other energy systems is electrified (meaning that another energy vector is replaced by electricity), the old interface rules are

129 Directive 2003/54/EC of the European Parliament and of the Council of 26 June 2003 concerning common rules for the internal market in electricity and repealing Directive 96/92/EC. OJEU L/176 of 15.07.2003

130 Directive 2003/54/EC used the word “system” just 167 times.

131 The exact wording of Directive 96/92/EC is as follows: “‘system user’ shall mean any natural or legal person supplying to, or being supplied by, a transmission or distribution system;”

132 Directive 96/92/EC mentioned the word “system” 129 times.

133 European Commission, *Powering a climate-neutral economy: An EU Strategy for Energy System Integration*, COM(2020) 299 of 08.07.2020. Pg. 1.

somehow “internalised” by the electricity system: from the physical point of view this process is straightforward and unequivocal, but from the transactional point of view there are usually several alternative approaches.

The growing number of uses of electricity through electrification (e.g., electric mobility) and the growing number of users, from small households to large industrial facilities, which increasingly generate, store and actively manage part of their electricity needs, make the current legal definition of “system user” (“a natural or legal person who supplies to, or is supplied by, a transmission system or a distribution system”) obsolete. Moreover, the massive decentralisation of electricity generation resources has made the old distinction between “transmission system” and “distribution system” equally obsolete. Therefore, it seems more appropriate to use the expressions “transmission network operator” and “distribution network operator” instead of “transmission system operator” and “distribution system operator”, respectively.

Tomorrow’s “electricity system” is both much larger and much smaller than the sum of a few “distribution systems” with a national “transmission system” interconnected with other national “transmission systems” – this kind of “system pyramid” is no longer appropriate to describe the evolving structure of multi-sector and multi-level energy architectures. The proper functioning of an integrated and integrative electricity network connecting many decentralised platforms with several large offshore platforms requires not only the (literal) rewiring of protection systems, but also the rewiring of control software.

Neither “transmission system operators” nor “distribution system operators” can fully protect and control the electricity system of the future – or any part of it, if it is physically interconnected. Therefore, it seems more appropriate to first (re)define systemic functions irrespective of ownership, voltage level or any other irrelevant attribute of those entities responsible for the construction, maintenance, observation and use of the infrastructure(s) that support the functioning of the electricity system – and to call network operators... just network operators. Only once these functions have been properly (re)defined should one discuss how they should be allocated – and to whom. Using the existing transmission and distribution “system operators” as a starting point for a discussion on future system operation may be a pragmatic approach, but it is certainly not the most logical, and the outcome of any “power sharing” agreement – voluntary or politically mediated – between network and market operators should be subject to a thorough technical consistency check.

Future system control centres will collect and process a range of information that is largely beyond the scope of any transmission network operator. On the other hand, although distribution level control centres will play an increasingly important role, notably in the management of local platforms, they lack the necessary information to ensure the proper functioning of the interconnected electricity system as a whole. Tight cooperation between transmission and distribution network operators is essential to ensure overall system reliability – a necessary but not sufficient condition.

As stated in the opening quote, “[t]he more we depend, the better” – but building the <links that liberate> is no easy task when so many habits (and vested interests...) hinder the transition to efficient, integrated energy systems.

11. GOVERNANCE AND REGULATION

“The bad news is that economic organization is made vastly more complicated by the numerous hazards that accrue to the combination of uncertainty with bounded rationality and opportunism. (...) The even better news is that human actors are often perceptive about these hazards and are rather good, even creative, in fashioning institutions that can mitigate them.”

Oliver E. Williamson ¹³⁴

Recent public policies, combined with recent technical trends, will inevitably lead to multi-sector and multi-level energy architectures ¹³⁵; the evolution of the Internal Electricity Market from a centralised monolithic “single market” to a “platform of platforms” is the logical consequence of these developments. Therefore, the governance and regulation of the Internal Electricity Market should be adapted as early as possible to enable and to accelerate this evolution. Any delay in this necessary transition will result in costly delays in meeting greenhouse gas emission reduction targets, in unacceptable inefficiencies in electricity transactions and energy resource management, and in avoidable stranded costs. Changes in these institutional arrangements (governance and regulation), together with a structural overhaul of electricity infrastructure (cf. Ch. 18 EU electricity networks or the tragedy of the missing commons), form the core of the EU electricity reform, which aims to enable the massive deployment of new technical solutions and business models.

Emerging multi-sector and multi-level energy architectures allow for efficient coordination of increasingly decentralised and integrated energy resources. Resource coordination can be direct (i.e., within a given local platform) and indirect (i.e., across different platforms through appropriate platform coordination). These energy architectures require polycentric governance structures. Such structures exhibit some advantages as compared to centralised systems; Elinor Ostrom, in her study on ecological systems, identified a number of benefits associated with decentralisation - and these can easily be transposed to energy systems, as shown in the table below:

Table 4 | **Advantages of polycentric systems in coping with design and long-term sustainability of systems**

Ecological systems (according to ¹³⁶)	Energy systems
Local knowledge	Local knowledge
Inclusion of trustworthy participants	Inclusion of trustworthy participants
Reliance on disaggregated knowledge	Bottom-up energy system integration
Better adapted rules	Better adapted rules
Lower enforcement costs	Lower enforcement costs
Parallel autonomous systems	Increased reliability and resilience

¹³⁴ Oliver E. Williamson, *The Mechanisms of governance*, Oxford University Press, 1996. Pg. ix.

¹³⁵ Cf. Jorge Vasconcelos, *EU electricity reform*, May 2022.

¹³⁶ Elinor Ostrom, *Understanding institutional diversity*, Princeton University Press, 2005. Pg. 281/2.

Polycentric governance of decentralised systems also has its own limitations. It is better suited to certain systems, but it is not a silver bullet, as Elinor Ostrom rightly pointed out¹³⁷:

“Polycentric systems are themselves complex, adaptive systems without one central authority dominating all the others. Thus, no guarantee exists that such systems will find the combination of rules at diverse levels that are optimal for any particular environment”.

The point is that, if properly designed, polycentric governance can deal with real-world diversity much better than centralised, monolithic governance. This is true of natural systems, and it is also true of man-made systems such as networks and markets. In theory, electricity markets can be fully decentralised, combining the inherent decentralisation of market agents in the marketplace with suitable polycentric structures to manage energy system integration, “without one central authority dominating all the others”. However, ensuring the reliability and stability of electricity systems inevitably requires “one central authority” – the judge of last resort, which decides preventively whether a given transaction is compatible with the integrity of the system and, if necessary, reactively brings the system back from alert, emergency or even blackout status to normal. Therefore, due to physical (network) constraints, a certain hierarchy has to be added to the basic polycentric structure.

The need to properly articulate (spontaneous) markets and (intentional) organisation has been well described by Williamson in the following terms¹³⁸:

“I submit that hierarchy is much more than a continuation of market mechanisms. In very much the same way as “War is not merely a political act, but also a political instrument, a continuation of political relations... *by other means*” (von Clausewitz, 1980, p.13, emphasis added), so likewise is hierarchy not merely a contractual act, but also a contractual instrument, a continuation of market relations *by other means*. The comparative contractual challenge is to discern and explicate the *different means*.”

Energy system integration should not be confused with the mere electricity and natural gas “coupling”, as it was discussed for some time in the EU or, more generally, with multi-carrier energy systems¹³⁹, as some debates on the creation of a new hydrogen transmission and distribution infrastructure might suggest. It is worth recalling the broad and detailed definition provided by the European Commission¹⁴⁰:

“Energy system integration – the coordinated planning and operation of the energy system ‘as a whole’, across multiple energy carriers, infrastructures, and consumption sectors – is the pathway towards an effective, affordable and deep decarbonisation of the European economy in line with the Paris Agreement and the UN’s 2030 Agenda for Sustainable Development.”

¹³⁷ Ibid., pg. 284.

¹³⁸ Oliver E. Williamson, *The mechanisms of governance*, Oxford University Press, 1996. Pg. 147/8.

¹³⁹ Cf. Soheil D. Beigvand, Hamdi Abdi and Massimo La Scala, *Multicarrier energy systems*, in Alessandro Rubino, Alessandro Sapio and Massimo La Scala (eds.), *Handbook of energy economics and policy*, Academic Press Elsevier, 2021.

¹⁴⁰ European Commission, *Powering a climate-neutral economy: An EU Strategy for Energy System Integration*, COM(2020) 299 of 08.07.2020.

Three main conclusions can be drawn from this definition:

- First, energy system integration is essential for decarbonisation.
- Second, as a systemic approach, it requires new, integrative procedures among carriers, infrastructures and sectors, to ensure the cohesion and coherence of the energy system ‘as a whole’. Energy modelling¹⁴¹ needs to evolve to meet these challenges.
- Finally, integration requires structural changes in the way each ‘sub-system’ is designed, managed and regulated.

It should be emphasised that “the objective of any economic reform is to bring changes in the institutional arrangement so that economic activities can be performed more efficiently”¹⁴² within a given policy framework and political context. Competition in electricity was invented in the early 1990s¹⁴³ and regulatory and governance solutions were designed and successively modified to improve economic efficiency. Competition in electricity is being reinvented at different levels and this requires regulatory and governance reform.

¹⁴¹ Cf. Carol A. Dahl, *International Energy Markets*, 2nd ed. PennWell Corporation, USA, 2015. Pg. 27 ff.

¹⁴² Subhes C. Bhattacharyya, *Energy economics. Concepts, issues, markets and governance*, 2nd ed., Springer-Verlag, 2019. Pg. 771/2.

¹⁴³ Cf. Ronan Boltan, *Making energy markets. The origins of electricity liberalisation in Europe*, Palgrave Macmillan, 2021. Ch. 2 Inventing competition.

12. EXPECTED BENEFITS OF DECENTRALISED SYSTEMS

“Animal spirits can’t be modelled”

Edmund Phelps¹⁴⁴

“Sometimes contemporary economists do recognize that the social context or individual decisionmaking changes. But they still insist on building models that generate sharp predictions, thereby assuming that economists can do what market participants themselves cannot: specify in advance exactly how the social context will change and how individuals will alter their understanding of markets and their forecasting behaviors. These models, too, can be put on a computer and run, because they view individuals as robots and markets as machines.”

Roman Frydman and Michael D. Goldberg¹⁴⁵

The adoption of **Digital, Distributed, Integrated Energy Systems** (DDIES) can be seen as a highly cumbersome necessity resulting from the adoption of structural changes in energy system design in the face of system-wide disruptive developments associated with the path to decarbonisation. However, adapting energy system design to accommodate decentralisation and integration is not only a challenge. In fact, seizing the opportunities of decentralisation and integration is expected not only to support decarbonisation, but also to benefit consumers and (new) service providers, as well as to increase the resilience of energy system. In this context, it is generally agreed that the benefits of decentralisation and integration hinge on sufficient levels of digitalisation and are enhanced by value stacking and energy system integration, which can and should be used as three key design guiding principles for DDIES.

A recent IEA study¹⁴⁶ illustrates this by analysing power system opportunities and best practices for unlocking the potential of Distributed Energy Resources (DER), with a focus on behind-the-meter installations. It notes that while “[t]he primary beneficiaries of DERs are the consumers who own them”, these DER can also be the answer to the challenges they create. For instance, smart charging of electric vehicles can help mitigate the negative impact of higher evening peak loads caused by electrified heat supply on distribution grids. Another example is installing advanced inverters “as a part of a distributed PV system [which] can not only provide its owner with solar generation data, but can be programmed to prevent the PV system from causing voltage problems for the distribution grid”. However, it also notes that “[u]nfortunately, many regulators and system operators have neither sufficient information on DERs nor adequate distribution grid monitoring equipment to take advantage of such capabilities”.

¹⁴⁴ Edmund Phelps, *Our uncertain economy*, The Wall Street Journal, March 14, 2008.

¹⁴⁵ Roman Frydman and Michael D. Goldberg, *Beyond mechanical markets*, Princeton University Press, 2011. Pg. 50.

¹⁴⁶ IEA, *Unlocking the potential of distributed energy resources – Power system opportunities and best practices*, 2022.

The Smart Electric Power Alliance (SEPA) defines value stacking “as the bundling of grid applications, creating multiple value streams, which can improve the economics for distributed energy resources. Bundling grid applications to stack multiple values can improve the economics for DER technology investments by improving the return on investment and reducing the payback period.”¹⁴⁷ The range of applications that can be covered by a single DER depends on the technical and non-technical requirements of the application and the ability of the DER to meet them. Battery storage systems are generally singled out when discussing value stacking strategies as they can bundle all possible DER applications, which in interconnected systems (i.e., excluding mini-grids)^{148 149} have traditionally fallen into two main categories:

1. Electricity consumers

- Increased self-consumption
- Backup power (increasing energy resilience)
- Savings on electricity bills
- Reduction in demand charges

2. System operation

- Frequency regulation
- Voltage support
- Congestion management
- Deferral of network investments
- Peak capacity investment deferral

Considering the emerging new business models enabled by DDIES, the range of possible DER applications increases even further. Distributed resources can be used to improve regional energy balance, increase revenues for distributed generators through peer-to-peer trading, and more. While the technical capability of DER to provide multiple services is given, there are several barriers to large-scale deployment of value stacking, including the lack of ICT for communication and control, legal and regulatory barriers, and ownership and business model barriers. The relevance of local circumstances and preferences in the context of value stacking becomes evident in issues concerning the value stacking prioritisation (e.g., one local system may need more voltage support while another may prioritise congestion management) and the level of acceptance for specific value stacking strategies by the DER owner (e.g., if the asset owner has high resilience requirements, the battery might not be available for system-oriented services).

Continuing with the battery storage example, in terms of impact assessment, the current framework conditions entail that it is primarily consumers who benefit from

¹⁴⁷ Smart Electric Power Alliance, *Maximizing Value from DERs Through Value Stacking*, 2019. <https://sepapower.org/knowledge/maximizing-value-from-ders-through-value-stacking/>

¹⁴⁸ Ibid.

¹⁴⁹ IRENA, *Behind-the-meter batteries – Innovation Landscape Brief*, 2019.

behind-the-meter battery storage. However, a US modelling study¹⁵⁰ estimates that only up to 50% of the asset's useful lifetime is spent on demand charge reduction, making the case for value stacking. The same study also found that the value proposition of value stacking could be further improved by pairing the battery storage with PV: for the use case considered, consumers could save 20% in their yearly electricity bill and still have 90% of their battery capacity available for other value streams, such as providing balancing services to a TSO.

¹⁵⁰ Garrett Fitzgerald et al., *The Economics of Battery Energy Storage*, Rocky Mountain Institute, 2015.

13. DIGITAL, DISTRIBUTED, INTEGRATED ENERGY SYSTEMS (DDIES)

13.1 Definition

For the sake of clarity, we provide the following preliminary definition of DDIES:

“Digital, distributed, integrated energy systems (DDIES) focus on solving the challenges and exploiting the opportunities associated with the decentralisation and integration of energy generation, demand, storage and flexibility resources. This is achieved by introducing new approaches to the design and exchange of energy-related products and services, embodied in a geographically localised electricity platform, comprising energy system integration mechanisms. Commissioned and possibly operated by a local entity, such as the municipality concerned, or by a company, the local platform will be embedded in the DDIES through an appropriate governance framework (independent of network asset ownership) and appropriate technical and economic interfaces.”

13.2 Enabling horizontal multi-sector integration

Horizontal, multi-sector energy system integration can only be efficiently achieved through Digital, Distributed, Integrated Energy Systems (DDIES).

Regardless of their particular configurations, DDIES are always characterised by a certain set of elements:

- **Local players:**

- *Local platform:* At the heart of each DDIES is a local electricity platform, the integrative pivot that embodies the new approach to energy system design. It covers all energy-relevant sectors, conceivably assembling individual single-sector platforms (e.g., for new mobility services and for renewable energy communities) where they exist locally. Like a coin, the local electricity platform has two sides: the physical network and the transactional space.
- *Local agents:* The local platform exchanges products or services for and possibly provided by local agents such as prosumers, RES owners, (local) business owners, local energy communities, local aggregators, etc.. Their participation in the local platform follows the pertinent rules of the transactional space, according to the locally agreed design and intended business logic.
- *Local authority:* The institutional entity (usually the municipality) that has the competence to specify the terms of reference and award all relevant local network concession contracts (e.g., for electricity distribution, district heating and cooling, public transport, waste management, water supply, etc.). Individually or collectively (e.g., as an inter-municipal association), they can also commission and possibly operate the local platform. In principle,

however, a local platform can also be commissioned and/or operated by a business-oriented player.

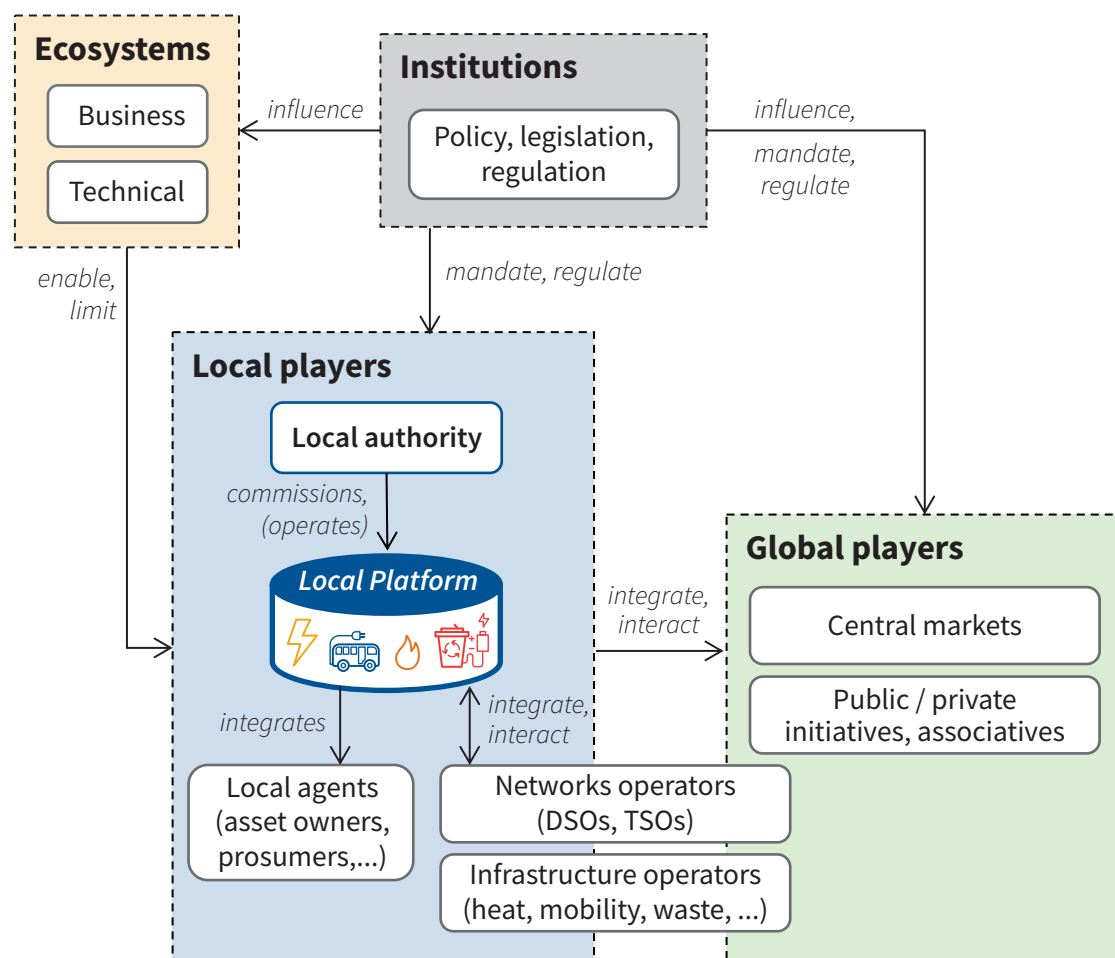
- *Network operators:* Local network operators are either directly involved in the processes of the local platform or should at least be considered through suitable interfaces, as they will most likely be affected in some way by the products or services provided by the local platform (e.g., changed power flows, new mobility patterns, etc.).
- **Global players:**
 - Analogous to local system and infrastructure operators, global players should be considered in the DDIES design according to their level of involvement, i.e., either as active members of the local platform or through appropriate interfaces that take into account interface interactions and interdependencies. Besides overlaying system and infrastructure operators, the global players include central energy markets and all public and private entities directly involved in or indirectly affected by the local platform processes.
- **Ecosystems:**
 - On the one hand, the scope and configuration of local platforms is largely determined by local needs and preferences (e.g., preference for local, sustainable supply options – e.g., renewable district heating - over conventional retail options – e.g., natural gas). On the other hand, existing business and technical ecosystems can have a significant impact on the uptake of DDIES. Favourable financing conditions, investment opportunities, technical maturity and availability can be key influencing factors for the timing and type of the DDIES set up.
- **Institutions:**
 - Entities responsible for establishing and enforcing policies, legal and regulatory framework conditions set the strategic course for DDIES development. This can occur either through specific provisions and targets or through a targeted intervention in the technical and economic ecosystems (e.g., introduction of financing programmes, conditional subsidies, etc.).

Bottom-up development of DDIES doesn't exclude efforts to maintain functioning and still needed elements of existing centralised energy systems. As long as a suitable interface is designed and implemented, and compliance issues are considered, DDIES will initially complement rather than replace current centralised energy systems.

Agreement on the key elements in defining the design requirements for DDIES will facilitate the exchange of best practices, the exploitation of intra- and inter-platform synergies, and the creation of higher market share potentials for the companies involved, thus enabling an orderly transition to increasingly decentralised and integrated energy systems.

The key elements common to all DDIES are described in more detail in the following sections.

Figure 27 | Digital, Distributed, Integrated Energy Systems (DDIES)



13.3 The local platform

As with many other relatively new concepts in the energy sector, there is considerable margin for interpretation in relation to DDIES. The aim of this report is not to add to the complexity by introducing yet another ‘definitive’ definition, but rather to attempt to structure developments around energy system decentralisation in order to distil the key drivers, features and interfaces that exist or need to be defined or adapted. All developments around energy communities, local markets, aggregation and other issues are thus not ignored, but rather used as a basis for the present analysis.

This report also aims to emphasise that a thorough and comprehensive decision support analysis is key to identifying the DDIES configuration that best suits local circumstances and preferences, while meeting (supra-)national policy targets and system-wide requirements. Understanding the starting point and framework of a local system before carrying out comparative assessments between the increasing number of available distributed energy systems approaches is crucial for identifying the best course of action for a given local system. It could also help to reduce the

risk of introducing new types of conceptual silos that make different DDIES configurations mutually exclusive. Why should the introduction of a local flexibility market exclude the possibility of also setting up a local energy or mobility services sharing platform, if the combination yields environmental, technical and socio-economic benefits, simply because of technical or governance incompatibilities between the respective providers?

At the core of each DDIES is the local platform, which incorporates the new product and / or service exchange paradigm and is embedded through appropriate interfaces in the local and overarching energy, techno-economic and legal-regulatory systems.

Key features of the local platform

Once the opportunities and the limiting factors of both the superimposed and the local system are known, the space of feasible design options for the local platform becomes clear. The design of the local platform envisages the configuration of a broad set of features:

- Fundamental goal: What is the primary function and scope of the platform (e.g., exchange of locally generated energy products / mobility services / ...)?
- Products / services: What will be exchanged on the local platform (electric energy products / heat products / mobility services / ...)?
- Participants: Who can own, operate and participate in the activities of the local platform (e.g., prosumers / utilities / communities /...)?
- Exchange / transaction procedures: How are products or services exchanged on the local platform (market mechanism / bilateral contracts / ...)? What are the time requirements? What is the remuneration mechanism?
- Legal framework: What legal form does / can a platform take (e.g., investor-owned business / cooperative / public body, ...) How are the roles and responsibilities of the platform stakeholders (owners, operators, participants) legally defined? Who bears what risk and liability (e.g., with regard to supply shortages, outages, voltage quality, etc.)?
- Interfaces: How does a local platform interact with overlying and neighbouring systems?

The design of a local platform requires decisions to be made about all these features. These decisions are driven both by exogenous factors (political, techno-economic drivers, legal-regulatory and governance frameworks) and by local circumstances and preferences of the actors involved. The latter gives the local authority (municipality, company in charge of setting up the local platform) a crucial role in the development of DDIES.

Key drivers for the choice of local platform design

The different configuration options for each feature and the possible combinations between them lead to a multitude of possible local platform designs. While the fundamental drivers (decarbonisation, citizen empowerment, economic efficiency) may apply to all design options, there are major local factors that influence the different design choices:

- First, the existing infrastructure of the given local geographical area can be a limiting or enabling factor for local platform design. For example, a local platform aiming to provide renewable heat to a given area might opt for a district heating platform if the district heating infrastructure is already in place, rather than for a solely heat pump-based approach.
- Second, the techno-economic ecosystems in place at the time of the decision to set up a local platform may promote specific designs and products while inhibiting others, and may even act as a trigger for the implementation of local platforms. Admittedly, ‘techno-economic ecosystems’ encompasses a wide range of factors, and in this case it is intended to serve as a generic term for exogenous influencing factors related to technical developments (e.g., the market entry of a new technical solution) and economic conditions (e.g., the introduction of a new funding programme). For example, the first introduction of feed-in tariffs for renewable energy sources in Germany with the EEG ¹⁵¹ in 2000 led to the creation of a large number of cooperatives that jointly invested in local renewable energy projects. Another example is the introduction of peer-to-peer trading platforms, stimulated by the technical development of blockchain, such as the LO3 Brooklyn Microgrid, introduced in 2016¹⁵².
- Third, institutional frameworks that enshrine local, national, continental or even global policies, regulations, norms and standards, etc. have a decisive impact on local energy-related developments. For example, the National Energy and Climate Plans (NECPs), the introduction of which was agreed as part of the Clean Energy for all Europeans 2019 package, define quantitative sectoral decarbonisation targets as well as economic or regulatory measures for local initiatives, some as specific as “[g]rants to municipalities for energy efficiency and sustainable local development investments” ¹⁵³. As a result, local authorities need to both support the developments needed to meet sectoral targets for consumers in relation to assets under their jurisdiction, and take advantage of the specific regulatory and economic resources allocated to local initiatives. These circumstances can have a significant impact on the choice of DDIES design.

Steering the bottom-up development of DDIES towards high-impact contributions to overarching goals and compliance with overarching system architectures is thus possible through ecosystem management and policy. It does not necessarily require a top-down specification of uniform DDIES designs.

¹⁵¹ Erneuerbaren Energien Gesetz (EEG), first introduced in the year 2000 and amended several times since then.

¹⁵² <https://www.brooklyn.energy/>

¹⁵³ Ministry of Economic Development, Ministry of the Environment and Protection of Natural Resources and the Sea, Ministry of Infrastructure and Transport: “Integrated National Energy and Climate Plan”; Italy; December 2019

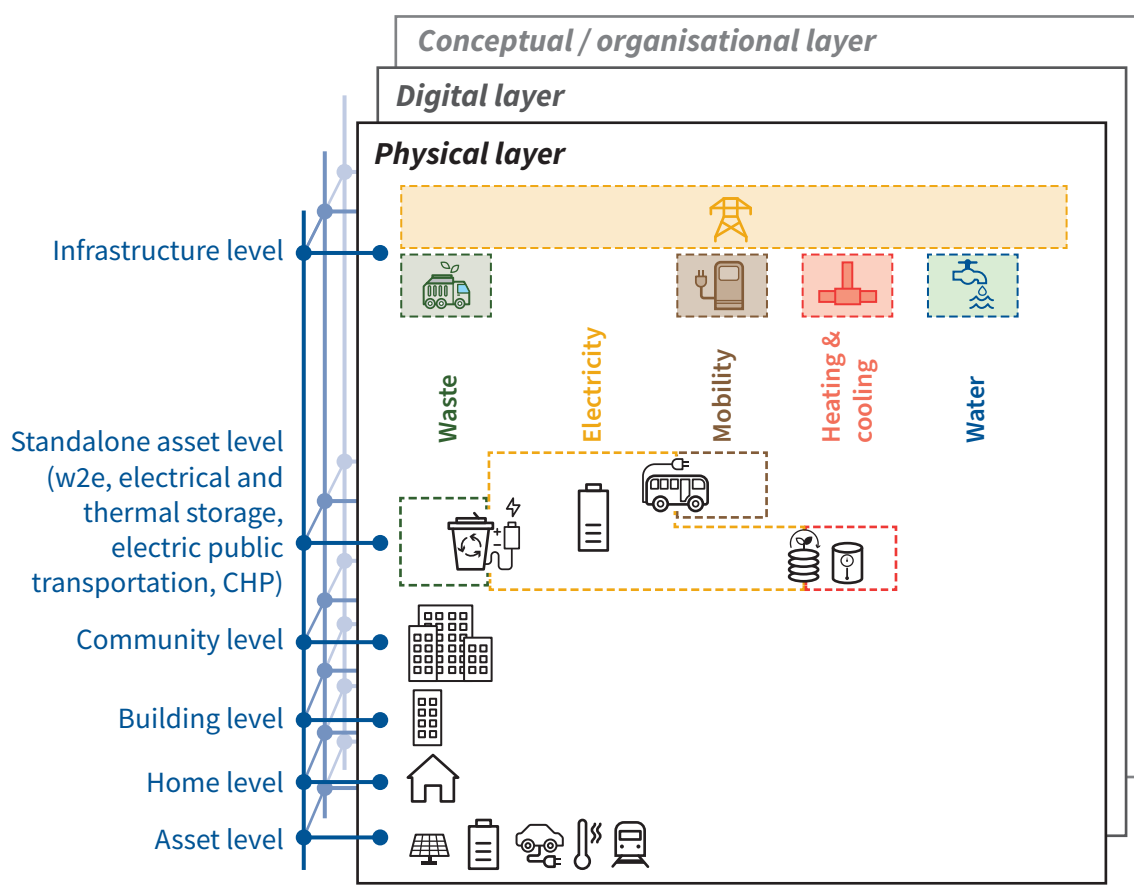
13.4 The interface question

The use of the singular when referring to the local platform in this Section is a deliberate choice to illustrate that, even if the horizontal competition model is ultimately established, there will need to be focal points of information convergence and coordination, as competitors will at least partially access the same resources (DER, infrastructure) and interact with the same global players (system and market operators, etc.). Consequently, in terms of interfaces, local platforms must:

- A)** On the one hand, meet the requirements within the local level to connect the different local solutions that together form a consistent and functional local platform of different products and services.

These individual solutions include different levels – from individual assets to whole infrastructures – and connect them according to the logic defined in the conceptual / organisational layer (e.g., the energy exchange between the rooftop PV, the battery storage, the garage charging station, the heat pump and the electrical and heat using appliances of a smart home is determined by a cost-optimising algorithm of an energy management system), through the digital layer (e.g., the assets and the energy management system of the smart home communicate through predefined gateways), and possibly through the physical layer as well (e.g., using electric cables to enable the energy exchange between PV and other assets), (see Figure 28).

Figure 28 | The 3 layers of DDIES

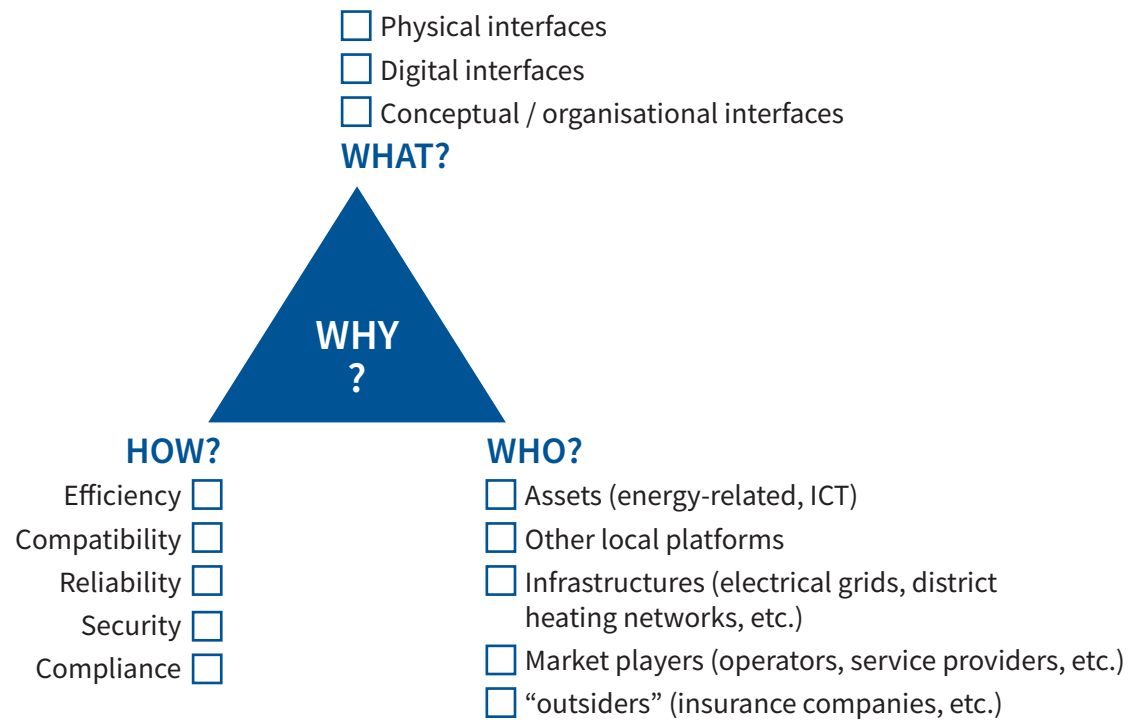


- B)** On the other hand, a local platform must also meet interface requirements that allow for a smooth integration into overlying systems and with neighbouring platforms. Local platforms are only one of the many components of the envisaged DDIES and their design must therefore ensure interoperability through viable interfaces.

Given the wide range of configuration options for local platforms, the resulting range of possible or necessary local platforms interfaces makes a “one-size-fits-all” solution impossible. However, there is a common procedure for identifying suitable interfaces, which can be broken down into four main questions (see box below and next figure):

1. ‘Why?’: Each interface has a specific purpose (e.g., enabling distribution network operators to control specific assets for grid-oriented purposes).
2. ‘Who?’: It is important to define who is at each end of the interface and whether it is a direct connection or there are other actors in between (e.g., does the distribution network operator have a direct interface to the controllable asset or is the asset reached indirectly through an aggregator?).
3. ‘What?’: To fulfil the stated purpose of connecting the identified parties involved, the interface needs to be described at the physical (e.g., Ethernet), digital (e.g., Modbus) and conceptual / organisational (content, frequency, duration of the exchange) levels.
4. ‘How?’: Among the resulting options for implementing a given interface, the one that best meets the following list of qualities should be selected: efficiency (does the interface minimise technical complexity and cost?), compatibility (does the interface interfere with other interfaces / local platform features?), reliability (how well does the interface fulfil its intended purpose?), security (is the interface physically and digitally secure?), compliance (does the interface comply with technical standards, legal-regulatory and governance requirements?).

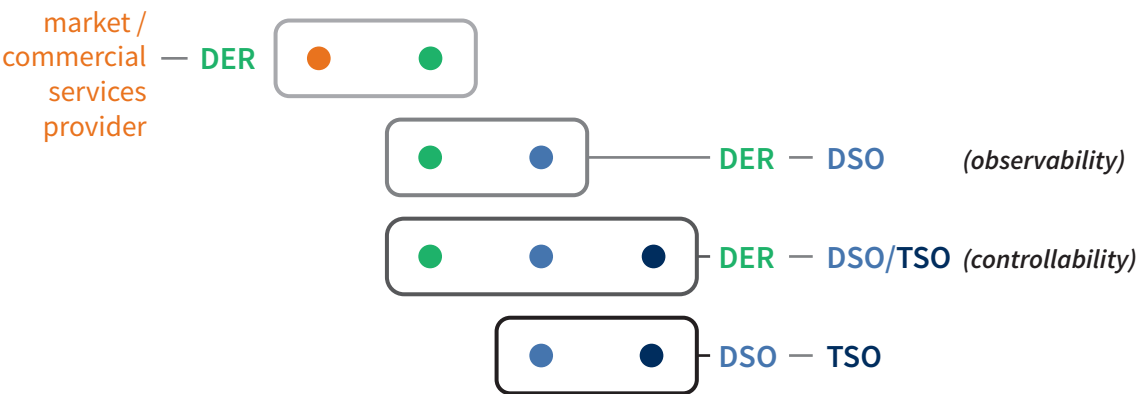
Figure 29 | Identifying DDIES interfaces



Local platform interfaces and Network Codes

Each asset connected to the platform is an integral part of the physical, interconnected network system. Consequently, the network operator(s) must be able to access the information on the operation of each asset at any level of accuracy or aggregation (observability) and, to some extent, control its operation (controllability). This is an increasingly crucial, but traditionally not always familiar, task for distribution network operators hosting an increasing share of distributed energy resources on their grids. Therefore, in addition to the potential business model-specific functional and ICT-related interfaces, a local platform must always include appropriate interfaces with the network operator(s) (see Fig. 30).

Figure 30 | DDIES interfaces in context



The suitability of network interfaces implies, among other things, compliance with a set of legal and regulatory framework conditions, some of which are common, some of which are specific to different countries or regions. At EU level, these framework conditions are mainly laid down in Network Codes. These documents were introduced in the Third Energy Package to promote greater harmonisation of national electricity markets.

The current scope of the existing Network Codes was mainly determined by the Clean Energy Package adopted in 2018/2019, which also identified additional areas requiring harmonisation and regulation through network codes and guidelines. The existing Network Codes are categorised into three ‘code families’ relating to connection, operation and market. The second generation of Network Codes and guidelines will cover demand response, energy-specific cybersecurity and a common consumer data format. A Network Code on Cybersecurity has been drafted but is not yet in force. For demand response, ACER has initiated the development of new framework guidelines in 2022.

Network Codes and guidelines usually address interface issues from a data exchange perspective. With varying levels of detail, these documents outline which data must be exchanged between which actors. Broadly speaking, data access is regulated at European level for network and market data and at national level for energy consumer data. In both cases, regulations generally include requirements for data transparency and publication, non-discriminatory access, data protection and cybersecurity.

The complexity of these data-oriented interfaces in the electricity sector stems from its pre-existing ‘system-of-systems’ characteristics¹⁵⁴. New applications and devices with new, sometimes proprietary IT systems are constantly being introduced into existing markets and networks, challenging their integration into existing systems and further hindering the integration of consumers, markets and networks. Data exchange interfaces are therefore needed to ensure interoperability at two levels: First, the technical possibility of transferring data from IT system A to IT system B; second, the ability of these systems to interpret the content of the transferred data.

There have been increasing efforts to improve the level of standardisation of data exchange processes at European level, such as the issuance of the Smart Grid Standardisation Mandate M/49, which, among other things, resulted in the Smart Grid Architecture Model (SGAM). However, there is still considerable scope for regional, national or even individual configuration of the data exchange processes, which, in the Network Codes, are generally assigned to network operators. For example, Article 18 of the Demand Connection Network Code¹⁵⁵ states that “[t]ransmission-connected demand facilities [or transmission-connected distribution systems] shall be equipped according to the standards specified by the relevant TSO in order to exchange information between the relevant TSO and the transmission-connected demand facility [or transmission-connected distribution systems] with the specified time stamping. The relevant TSO shall make the specified standards publicly available”. It further contains a paragraph on information exchange standards: “The relevant TSO shall specify the information exchange standards. The relevant TSO shall make publicly available the precise list of data required.”

¹⁵⁴ Florence School of Regulation: *The EU Electricity Network Codes* (2020 ed.)

¹⁵⁵ Commission Regulation (EU) 2016/1388 of 17 August 2016 establishing a Network Code on Demand Connection

The ‘transmission system-centrism’ enshrined in the Demand Connection Network Code is also found in the System Operations Network Code. For example, in Article 23 (3): “[w]hen preparing and activating remedial actions which have an impact on the transmission-connected SGUs and DSOs, each TSO shall, if its transmission system is in normal or alert state, assess the impact of such remedial actions in coordination with the affected SGUs and DSOs and select remedial actions that contribute to maintaining normal state and secure operation of all involved parties. Each affected SGU and DSO shall provide to the TSO all necessary information for this coordination” Or in Art. 4: “[w]hen a TSO activates a remedial action each impacted transmission-connected significant grid user and DSO shall execute the instructions given by the TSO”. At the same time, the System Operations Network Code attempts to actively shape standardization efforts by stipulating that “by 24 months after entry into force of this Regulation, ENTSO for Electricity shall, pursuant to Articles 115, 116 and 117, implement and operate an ENTSO for Electricity operational planning data environment for the storage, exchange and management of all relevant information”¹⁵⁶. This data environment aims at developing and implementing a common grid model for all stages of system operation.

The need to move away from a strict top-down, TSO-centric approach to the configuration of data exchange processes is reflected in the most recent Network Code on Cybersecurity¹⁵⁷, which is still at a draft stage. For example, it states that “[w]ithin two (2) years after entry into force of this Regulation, the ENTSO for Electricity in cooperation with the EU DSO entity shall assess the possibility and the financial feasibility to develop a common tool for all entities with automatic connections to the CSIRT¹⁵⁸ network tools”.

While it is expected that the remaining Network Codes on the roadmap will expand the scope of the current legal and regulatory framework to take account of the increasingly distributed reality that affects all ‘code families’, there is another dimension that is often excluded from standardisation and interoperability efforts. Energy system integration (also known as sector coupling), which is the cornerstone of local platforms, influences interface design from both a business and a functional point of view, which in turn affects the data exchange processes addressed in the Network Codes. First steps have been taken to address the interactions between sectors (e.g., ENTSO-E and ENTSO-G have been working together for the last three years to develop a joint Scenario Report for their respective TYNDPs), but major energy system integration efforts would require a robust and interoperable basis for data management and exchange between stakeholders.

¹⁵⁶ Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation

¹⁵⁷ ENTSO-E, EU DSO, *Network Code for cybersecurity aspects of cross-border electricity flows*, 14 January 2022

¹⁵⁸ CSIRT is an acronym for computer security incident response teams established pursuant to Article 9 of Directive (EU) 2016/1148

Local platform interfaces – practical implementations

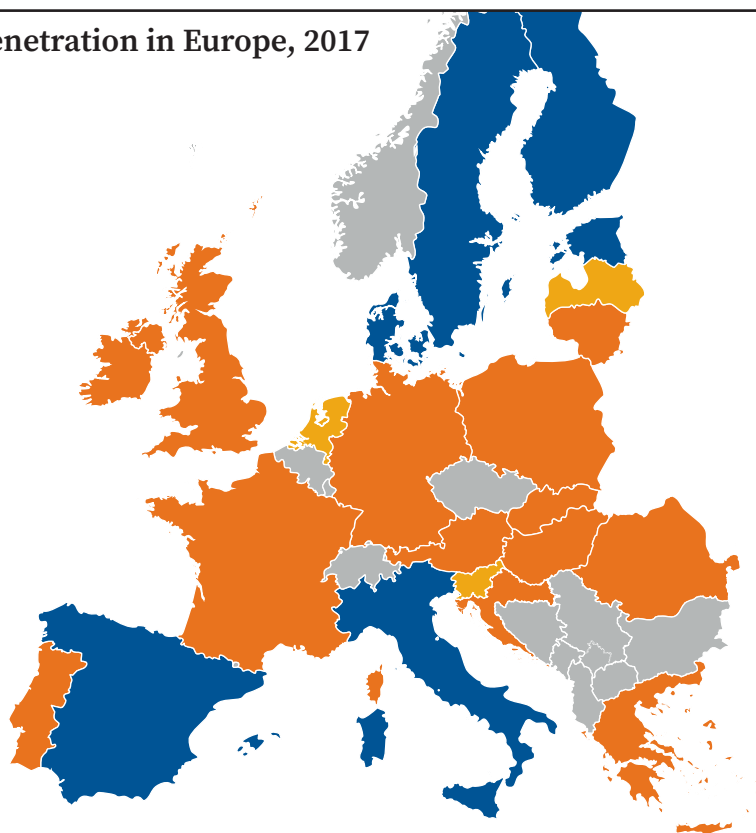
The level of maturity of the interfaces relevant for, but not limited to, local platforms differs significantly according to the use case and local circumstances (e.g., availability of smart meters). Roughly speaking, the availability of mature interfaces decreases from the top to the bottom in Figure 30. The connection of DER to electricity markets or their interaction with commercial service providers (e.g., demand-side aggregators, virtual power plants, etc.) is increasingly common and enabled by state-of-the-art ICT systems and protocols.

Interfaces aimed at increasing the observability of DER and, more generally, of distribution grid operation, vary widely in terms of maturity among European DSOs (see Fig. 31). While in Italy, for example, ENEL began the installation of smart meters in 2001 and reached an almost 100% penetration level by 2017, Germany still had no significant smart meter penetration in 2017¹⁵⁹. Clearly, full observability can only be achieved through an appropriate ICT infrastructure capable of collecting and processing data from the installed smart meters, usually owned by the distribution network operator. Building and using this infrastructure requires specific expertise and resources, which large DSOs tend to have in-house, but small and medium-sized DSOs do not. In the latter case, outsourcing has been a widespread option, which has led to an increased share of new, digital companies aiming to fill this gap (e.g., Adapticity, Opus One, envelio).

Figure 31 | Smart meter penetration in Europe, 2017

- High (>70%)
- Medium (30-70%)
- Low (<30%)

It does not include data from Belgium, Bulgaria and Czech Republic



Source: Monitor Deloitte

¹⁵⁹ Eurelectric, Deloitte, E.DSO, *Connecting the dots: Distribution grid investment to power the energy transition*, 2021.

Maturity assessment becomes more complex for the next two categories of interfaces. Many proprietary or outsourced solutions for observability include bi-directional communication protocols and could therefore provide DSOs with the technical capability to control DERs. However, **in the case of DER-DSO-interfaces aimed at controllability, some key business and functional aspects of the interface design remain open.** In particular, there is a lack of a generally accepted definition of the scope (when, for how long, how much) and context (how) of DSO control over DER for system operation purposes, given the potential overlap with third party control of DER for commercial purposes. This renders the identification of necessary interoperability standards for the technical interface design rather challenging.

To address this issue, public funding has been provided at both at national and European level for research projects to explore novel architectures and corresponding technical solutions. Piclo (see Box on next page) is an example of a successful transition from an early, mainly publicly-funded trial phase to a company providing grid-oriented services across several countries. With its flexibility platform, Piclo provides a customised answer to questions about the scope and context of DSO control over DER. However, the question of business interoperability (i.e., how can DER participate in other platforms at the same time?) remains open, as in other examples of such solutions (e.g., enera¹⁶⁰, gopacs¹⁶¹, etc.). Ideally, European ICT interoperability standards would anticipate these developments and ensure that any platform-specific solution would be able to enter into data exchange processes with actors that are not directly involved in the same platform but want to access the same DER.

160 <https://projekt-enera.de/>

161 <https://en.gopacs.eu/>

Flexibility Markets – The Piclo example¹⁶²

Company profile

Piclo is a UK-based company and the operator of “Piclo Flex” – a platform-based marketplace that enables system operators to procure flexibility from registered distributed resources. Piclo was founded in 2013 and received several grants before launching its platform in 2018. Since securing its first commercial contract in 2019, the company was awarded 47 million £ worth of flexibility contracts, registered almost 14 GW of flexibility capacity and procured 667 MW of capacity for system operators in the UK.

Basic functioning

The core of the concept is the “Piclo Flex” platform-based marketplace. Flexibility providers submit bids within a defined procurement window, which system operators can accept or reject. On the procurement side, system operators can also proactively advertise their flexibility needs and incentivise the submission of suitable bids. In addition to the procurement process, “Piclo Flex” supports the monitoring and control of the process leading up to the flexibility dispatch by monitoring the availability of the assets and relaying dispatch instructions and schedule messages. It also supports the settlement process with metered service verification and invoicing.

Finally, the fourth category of interfaces, DSO-TSO coordination, adds another dimension to the complexity of the business, functional and technical interface design. In addition to interacting with markets or commercial service providers, DSOs claim controllability over DER for system operation purposes – a claim shared by the overlying TSOs. As with the previous category, the lack of a generally accepted definition of the scope and context of TSO control over DER poses a challenge to standardisation efforts. In theory, TSOs can access DER either directly, through a commercial service provider acting as an intermediary, or through the relevant DSO. This significantly changes the associated data exchange processes and the resulting requirements to system and communication protocols.

These issues have also been the focus of numerous research efforts, with particular relevance in recent EU Horizon 2020 calls. A major effort in this context is the OneNet project, which aims to develop an architecture that enables the entire European electricity system to operate as a single system. This fundamental objective includes the ambitious, self-proclaimed step of converging the results and filling the gaps of previous EU Horizon 2020 projects on ICT architectures, both at the level of specific protocols for data exchange and of the underlying conceptual (logic that dictates the how, when and why of data exchange) DSO-TSO coordination schemes. This is in line with the recommendations of the European Commission’s BRIDGE initiative on DSO-TSO

¹⁶² <https://www.piclo.energy/>

coordination¹⁶³. The main recommendations include the development of a conceptual European data exchange model and the definition of “interoperability of platforms”.

Intermediate results¹⁶⁴ of the OneNet project show that the analysed DSO-TSO coordination schemes follow one out of two approaches: the *ad-hoc* approach involving the development of a new platform that could be integrated into existing system operator systems, or the approach using an external data exchange platform such as Est-feed. Similarly, the intermediate analysis showed that current implementations of relevant communication protocols follow either the Client-Server Paradigm or the Publish-Subscribe paradigm. Assessing the general and use-case specific advantages and disadvantages of the different set-ups is key to identifying suitable harmonisation and standardisation pathways. If the project succeeds in developing the envisaged “OneNet Framework”, it could make a very significant contribution to overarching interoperability and data handling in EU electricity systems.

163 BRIDGE, *TSO-DSO coordination – Regulation WG and Data Management WG*, 2019

164 Néstor Rodríguez Pérez et al., *ICT architectures for TSO-DSO coordination and data exchange: a European perspective*, in IEEE Transactions on Smart Grids, 2022

14. DDIES IMPLEMENTATION CASES IN EUROPE

As the concept of Digital, Distributed, Integrated Energy Systems (DDIES) has been introduced in this report with the explicit intention of not limiting decentralisation initiatives to one objective or sector and not ignoring integration issues, the following cases of DDIES implementation in Europe gather practical implementation examples of a variety of different local platform concepts. As a reminder, local platforms have been defined as the materialisation of new geographically limited, generally sectoral approaches to the design and exchange of energy-related products and services, embedded in overarching energy systems through appropriate interfaces and governance models.

The aim of this section is not to provide an exhaustive overview of practical implementations in Europe, but rather to help re-evaluate the way in which these practical examples are categorised and used to derive best practices on the basis of selected examples. A common finding from many practical implementations is that the benefits of the platform can be maximised by exploiting the opportunities of both value stacking, to maximise the benefits from a single resource, and energy system integration, to maximise the benefits in terms of system-wide decarbonisation, investment and operational efficiency. Therefore, for the purpose of deriving best practices in terms of scope and impact assessment, it may be more helpful to categorise practical implementation examples according to the scheme shown in the table below, rather than according to the local platform concept (energy community, virtual power plant, etc.). The “value generating options” of the DDIES, i.e., their main objectives, have been abstracted and three main groups have been identified.

Table 5 | **Assessment matrix for local energy platforms**

<div>Sector</div> <div>Objective</div>	A. Electricity	B. Heating / cooling	C. Gas	D. Mobility	E. Waste	F. Water	(A + B).	(A + C).	...
1. Promote deployment (investment) of sustainable assets									
2. Promote efficient and sustainable energy supply and demand strategies									
3. Promote DER contribution to efficient infrastructure operation									
(1 + 2).									
(1 + 3).									
...									

Electricity Platforms

The implementation of local platforms focused on promoting the deployment of sustainable assets, i.e. mainly RES, is widespread and represents the most established local platform concept. Early public incentive mechanisms to promote the development of renewable energy sources offered significant financial incentives to individuals and communities, which, together with growing awareness of sustainability issues, led to the desired goal of increasing the share of RES in electricity generation. Decentralised RES investment projects can be broadly divided into those that are proactively initiated by citizens, often targeting municipal areas, and crowdfunding projects, which can even have a transnational scope. The latter can be further subdivided into debt-based, equity-based and non-investment crowdfunding models.

One of the many examples of this type of local platform is the Grenzland pool of community wind and ground-mounted PV farms. It comprises five wind farms with a total installed capacity of around 100 MW. The five wind farms are all individual companies 100% owned and operated by local farmers, residents and other community stakeholders. Municipalities in the relevant area participated financially in the projects to demonstrate their commitment and build trust in the early stages of the project. One reason for highlighting the Grenzland pool example is that it illustrates how local platforms can be sustainably effective and beneficial if they do not get stuck in fixed business models or conceptual silos, but rather evolve by adapting to changing circumstances. For example, the project started with the aim of generating and selling the electricity from five wind farms, and now some of the operating companies use some of their self-generated electricity to convert it into green hydrogen using a local electrolyser. The hydrogen is then used either for power-to-gas or to fuel the regional hydrogen vehicle fleet. Furthermore, the Grenzland pool community wind farm has managed to switch from the expired remuneration scheme via feed-in tariffs to a Power Purchase Agreement.

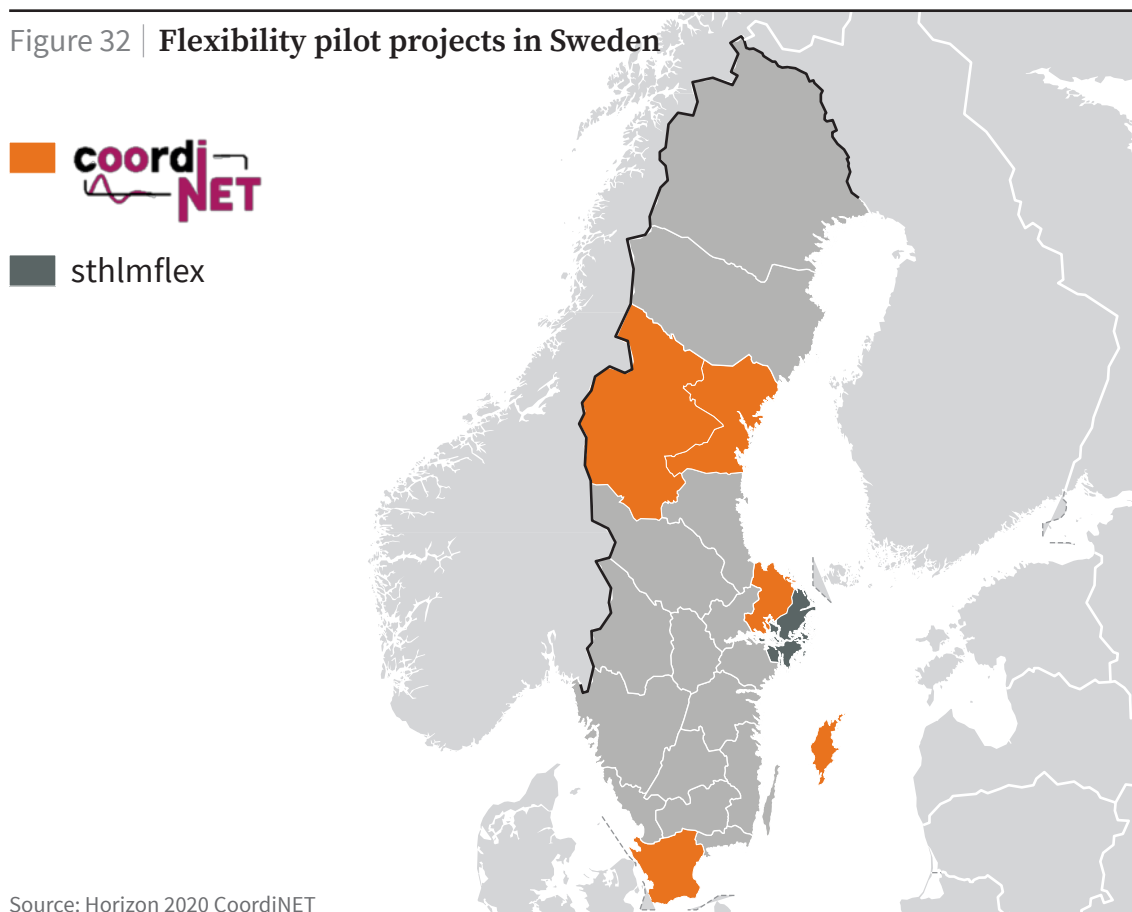
Another category of practical examples for local platforms focusing on the electricity sector aims to promote efficient and sustainable energy supply and use. These examples generally focus on innovative strategies for local resource allocation, either from a more technical perspective, i.e. focusing on the development of novel digital control strategies, or by providing novel approaches to energy exchange and balancing mechanisms, i.e. local trading, aggregation etc.. For example, the company SunContract¹⁶⁵ provides an energy marketplace for residential and commercial energy consumers to trade energy directly with each other (peer-to-peer). They offer competitive prices through direct price agreements between generators and consumers as well as free access to real-time energy data monitoring for their participants. SunContract is a good example of a local platform that actively responds to individual / local circumstances and preferences by enhancing its product and service offering. For example, electricity generators can choose how to deal with their surplus electricity according

¹⁶⁵ <https://suncontract.org/>

to their preferences: they can sell their entire surplus under a one-year contract, sell their surplus directly to energy customers at a bilaterally agreed price, transfer their surplus at the end of the year to someone else, or carry it over to the following year.

Another growing category of electricity-based implementations of local platforms aims to enhance the contribution of distributed energy resources (DER) to ancillary services. A common motivation among pioneering projects is to use DER to help alleviate structural bottlenecks in the electricity grid, at least during the transitional period while the necessary grid expansion measures are carried out. At both European and national level, different policies and regulatory measures have been taken to increase the use of (distributed) flexibility in grid operation. In Sweden, for example, the government's National Electrification Strategy emphasises the "efficiency first" principle and explicitly states that flexibility markets must be an integral part of the system. As in other European countries, several pilot projects for flexibility markets have been carried out in Sweden (see Figure 32).

Figure 32 | Flexibility pilot projects in Sweden



Source: Horizon 2020 CoordiNET

The Horizon 2020 CoordiNET project covers the regions of Uppland, Skåne, Gotland and Västernorrland/Jämtland and has successfully completed the demonstration phase after three winter seasons. In this flexibility market, the DSOs (Vattenfall and E.ON Eldistribution) are the buyers, and Flexibility Service Providers (FSPs), which include aggregators, real estate companies, local electricity generators, large electricity users and storage, are the providers. The matching of supply and demand takes

place on a digital marketplace called SWITCH and is based on the merit order market design. In addition to competing with each other, flexibility providers must outbid the conventional alternative, which in Sweden is the purchase of temporary subscriptions to the transmission grid. An interesting fact about the Swedish demonstrators of the CoordiNET projects is that while the municipality, although not directly involved in the project, played a key role in finding FSPs. In terms of best practice, the Swedish demonstrators concluded that while there are some noteworthy benefits from the introduction of flexibility markets (partial relief of grid congestion, improved load forecasting for DSOs), the lack of liquidity and profitability raises concerns about the longevity of FSP participation in flexibility markets. It was also found that while direct participation in energy systems can have an empowering effect and possibly financial benefits, it also creates administrative and time burdens for participants whose day-to-day business does not relate to optimising, buying or selling energy. The role of aggregators or other types of intermediaries has therefore been strengthened.

Heating and cooling platforms

While most local platforms have been set up to manage (local) electricity generation and demand, they are increasingly also, or exclusively, dealing with the generation and sharing of energy for heating and cooling. Dutch researchers who have coined the term “thermal energy community” (TEC) estimate that there are more than 370 TECs in the Netherlands and probably a higher number than that in Germany¹⁶⁶. As electricity-based initiatives can directly use generation from renewable energy sources, they tend to have less complex organisational requirements and infrastructure costs. Most TECs don’t limit their focus to just heating and cooling, but generally take a combined approach with electricity¹⁶⁷.

An example of a local platform focusing on improving the heat supply for a community is the Smartes Sonnen- und Bioenergiedorf Mengersberg. Unlike the majority of German TECs, which were set up because a large biogas plant was built first and then customers had to be found to buy its waste heat, the community of Mengersberg reversed the process and commissioned a feasibility study to determine the best way to establish a sustainable heat supply¹⁶⁸. On this basis, a combination of technical devices was selected, namely a standalone solar thermal plant, a wood chips fired boiler and a biopropane-fired boiler for peak load and redundancy, supplying 150 local consumers via a 9 km network. While the dedicated cooperative is taking on the 6 million euro debt-financed investment, the municipality is guaranteeing for 80% of the loan, demonstrating once again the crucial role of local authorities in facilitating the creation of DDIES.

¹⁶⁶ <https://solarthermalworld.org/news/from-lecs-to-tecs-citizen-energy-in-focus/>

¹⁶⁷ Fouladvand, J., et al., *Analysing community-based initiatives for heating and cooling: A systematic and critical review*, in Energy Research & Social Science, Volume 88, June 2022

¹⁶⁸ <https://www.dbfz.de/projektseiten/smart-e-bioenergie/beispieluebersicht/mengersberg>

Mobility platforms

Mobility is an interesting sector from a DDIES perspective, as considering it only in terms of electricity demand patterns and the flexibility potential of the electrified share of the local vehicle fleet can have a distorting and reductive effect on the assessment of its potential. Decarbonisation of the transport sector goes beyond the “one-to-one” electrification of individual vehicles, commercial fleets and public transport vehicles. It has triggered a re-evaluation of established mobility patterns, by challenging traditional individual vehicle ownership trends with car-sharing models and enhanced public transport services. Prominent examples of mobility-oriented local platforms include innovative mobility services instead of or in addition to smart charging services. Smart charging is actually better placed in the ‘electricity’ category of local platform implementations in the approach suggested in this report, as it is generally limited to controlling the behind-the-meter charging process of individual electric vehicles in combination with the energy management of other electrical appliances in a given home.

Committed to promoting walking, cycling, public transport and, as a last resort, car sharing over conventional mobility models, the non-profit consumer cooperative Som Mobilitat offers corresponding novel mobility services on a digital platform¹⁶⁹. The cooperative has set up an organisational structure that aims to take advantage of a global response to the local mobility challenges. It therefore operates as a network, in which local groups at municipal level are responsible for promoting and adapting the products and services offered by Som Mobilitat to the local circumstances. At the same time, the cooperative has created the first network of mobility cooperatives¹⁷⁰ under the REScoop umbrella to share best practices and resources at European level.

Som Mobilitat’s approach highlights the need to take account of local circumstances in order to achieve a successful mobility transition, putting local authorities back at the heart of the action. Identifying suitable local mobility services requires an understanding of the demographic, geographical and cultural specificities of a local community. For example, the mobility patterns of a community consisting mainly of commuters will be very different from those of a community where people live and work in a small geographical area. The age structure of the community may influence the level of convenience required (e.g., public transport may be preferred to cycling by the elderly) and cultural characteristics may influence the acceptance of certain services (e.g., where car ownership is an important status symbol, individual car ownership, possibly combined with a car sharing model, may be preferred to public transport options).

¹⁶⁹ <https://www.sommobilitat.coop/en/>

¹⁷⁰ <https://www.rescoop.eu/network/all/mobility>

Cross-sectoral platforms

Among the increasing number of practical implementation examples of local platforms, there is a trend towards approaches that integrate at least some sectors. This is due, on the one hand, to the increasing degree of electrification (heat pumps, electric vehicles, etc.), which renders energy system integration inevitable. On the other hand, cross-sectoral approaches help to enhance the expected benefits of the platforms – be it adequate participation and (financial) (co-)ownership, the creation of more social cohesion, or the reduction of energy bills, among others.

A number of examples support these assumptions. For instance, the ZuidtrAnt cooperative, based in and around Antwerp, covers a wide range of activities, including PV generation, district heating, advice on energy efficiency measures for buildings, shared electric mobility and numerous climate awareness raising activities¹⁷¹. The energy cooperative also supports municipalities in implementing measures from their energy and climate action programmes, for example by providing affordable renewable electricity for public use, and the municipalities in turn promote the cooperative, thus increasing public support. ZuidtrAnt wants to expand its scope even further by exploring the possibilities of integrating storage and hydrogen into its asset portfolio.

The benefits of planning a local platform approach from the start of new construction projects are demonstrated by the company Spectral in the Republica Microgrid¹⁷². By being involved from the start, Spectral was able to develop a comprehensive and complex approach to the community's energy management. The result was a self-designed microgrid that manages a wide range of assets (community battery, PV panels, an aquifer thermal energy storage system (ATES), heat pumps, above-ground thermal energy buffers, EV charging points, and building HVAC systems) and covers a wide range of activities focused at both local (peak shaving, maximising solar self-consumption) and national levels (frequency regulation services to relieve the grid). Spectral has also strengthened the local energy cooperative consisting of local residents and businesses, which plays the role of local energy supplier and grid operator. Green-field approaches certainly enable a wider reach of local platform but are not a necessary prerequisite.

171 <https://www.zuidtrant.be/>

172 <https://spectral.energy/project/republica-microgrid/>

PART IV

Connecting the dots

15. ENABLING VERTICAL MULTI-LEVEL INTEGRATION

“When interconnected, a single system of hierarchy is confronted with multiple hierarchies, which crosscut each other in strange and unpredictable ways. Local patterns are robbed of their naturalness and lose any sense of determinacy. The “constructed” nature of society becomes apparent, or at least more apparent than it would otherwise be. There are options.”

John Gerring et al.¹⁷³

The European interconnected electricity system is a *sui generis* organisation, a *de facto* informal hierarchy that resists all attempts to create a formal *de jure* hierarchy – whether the institutionalisation is meant to simply match the *de facto* hierarchy or to lead the way to a new set-up. Since the 1950s, this persistent culture of ambiguity has enabled some positive advances towards greater interconnectedness, but it has also been responsible for significant welfare losses. Building a more efficient Internal Electricity Market, i.e., designing and assembling a “platform of platforms”, requires addressing the main factors of ambiguity.

Ambiguity concerns several aspects, namely:

- The relationship between transmission network operators and national governments.
- The relationship between the collective body of EU transmission network operators (from UCPTÉ, in the 1950s, to ENTSO-E nowadays) and the European Commission.
- The internal (i.e., within the collective body of transmission network operators) decision-making process.
- The EU rule-making process concerning the production of common rules for the development and operation of the EU’s interconnected electricity system.

Everywhere, electricity transmission networks play an objective role in ensuring security of electricity supply. Almost everywhere, their history is intertwined with the history of the respective countries: for example, the way in which electricity networks were nationalised or privatised, assigned national scale or restricted to regional areas, etc., reflects particular moments in national history, very often in a post-war context. The development of electricity transmission networks also reflects national policies, namely the sequence of choices of primary energy sources for electricity generation (the so-called “energy mix”). The current debate on electricity versus hydrogen networks¹⁷⁴ is a recent example of how electricity transmission networks have been, and continue to be, highly political objects. Therefore, their symbolic, subjective value cannot be ignored, even if it usually remains unspoken.

¹⁷³ John Gerring et al., *The deep roots of modern democracy*, Cambridge University Press, 2022. Pg. 385.

¹⁷⁴ Cf. Financial Times, *Europeans split over green hydrogen transport*, 23.12.2022. Pg. 7.

Cross-border electricity interconnections are always built to share some direct or indirect benefits. Direct benefits result from trade between areas with different generation costs; indirect benefits include, for example, less investment in generation capacity due to lower generation capacity reserve needs as compared to an isolated system. On the other hand, the construction of interconnectors entails (investment and operational) costs that have to be shared somehow. Due to the very long lifetime of electricity transmission assets, it is difficult to establish an accurate full cost-benefit account. This inevitable uncertainty is perceived by many managers – and politicians – as an unconfessable weakness. In recent years, a biased application of cost-benefit and similar analytical tools has often been used to “prove” the lack of value of several transmission and energy digitalisation projects, overestimating costs and underestimating benefits (direct and indirect, short- and long-term). In many cases, this negative bias has been an unconscious attempt to simultaneously a) avoid expressing the difficulty of quantifying relevant indirect benefits (e.g., related to security of supply) that can only be achieved through increased cooperation and coordination, and b) maintain the familiar *status quo* – not only in physical terms, but above all in the way the single market works from an institutional viewpoint.

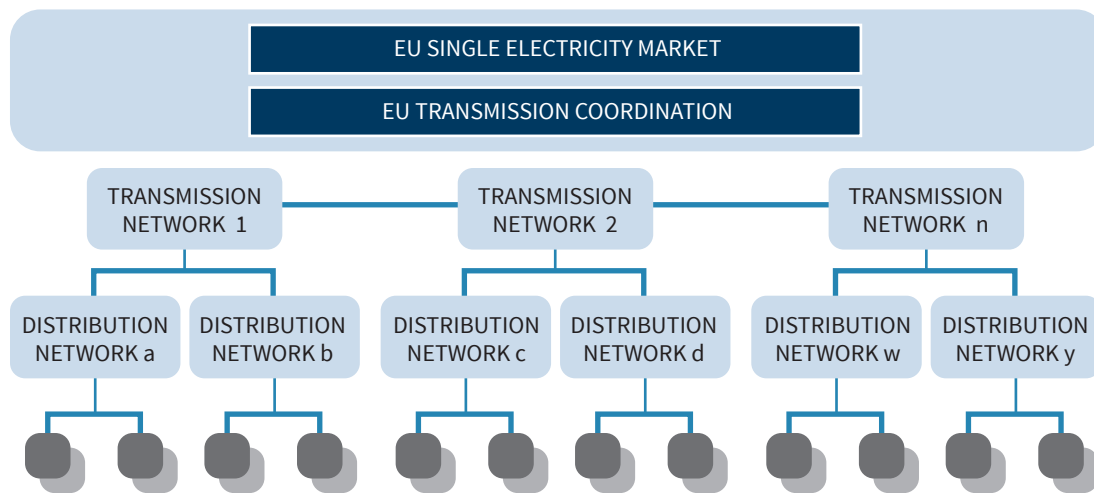
Beyond the strong, objective presence of imposing steel towers and endless copper and aluminium cables, projecting hard power and State “sovereignty” in our landscapes, there is a hidden manifestation of “conflict of hierarchies”, because in any interconnected electrical network sovereignty is a relative value - since stability is a common good, any significant disturbance travels at the speed of light through the whole network and individual (regional, national,...) network protections are only effective if they take into account the mode of operation of the whole interconnected network.

Instead of accepting the integrated nature of the continental interconnected network and setting up an appropriate – integrated – institutional governance aimed at optimising its use and development, Member States have decided to keep the “power” over the interconnected system as fragmented as possible, thus maintaining the illusion of national sovereignty in the electricity realm. Transmission network operators are happy with this arrangement because they do not “lose power” to an European Independent System Operator and can further thrive on their ambiguous “power sharing” among peers – the more “regional units” are established, the more the “power” of national transmission network operators is secure; the European Commission is also happy because it keeps its ambiguous role of co-legislator and co-regulator, mixing at EU level what EU legislation (rightly...) prohibits at national level, thus not “losing power” to an Independent European Energy Regulator. The same goes for National Regulatory Authorities. Traders are even happier because for them this situation means much more than just keeping symbolic capital – the more governance is fragmented, the more opportunities there are for arbitrage (their very *raison d’être*...) and forum shopping.

Decarbonising Europe’s energy system requires a structural transformation of the EU’s electricity system, and this transformation requires a new governance for the multi-level vertical integration of electricity platforms across Europe. Historically, the

Single Electricity Market has been perceived as the focal point and integrative pivot of recently liberalised national wholesale electricity markets, each physically supported by a national transmission system operator – see next figure. Within the distribution networks, a growing number of ‘black boxes’ emerged in recent years, corresponding to distributed electricity generation and other energy resources; at the same time, bi-directional electricity flows have become more common, replacing the old uni-directional paradigm.

Figure 33 | EU electricity structure – past



Initially, these ‘black boxes’ were passive elements, unobservable and unobserved by so-called system operators, uncontrolled – and not very noticeable. However, thanks to the digitalisation of energy, the black boxes started organising themselves as “mini local platforms” (i.e., atomised Energy Management Systems), unobserved and uncontrolled by system operators but locally controlled by their owners or by third parties (e.g., fleet managers, energy community managers), manually or automatically.

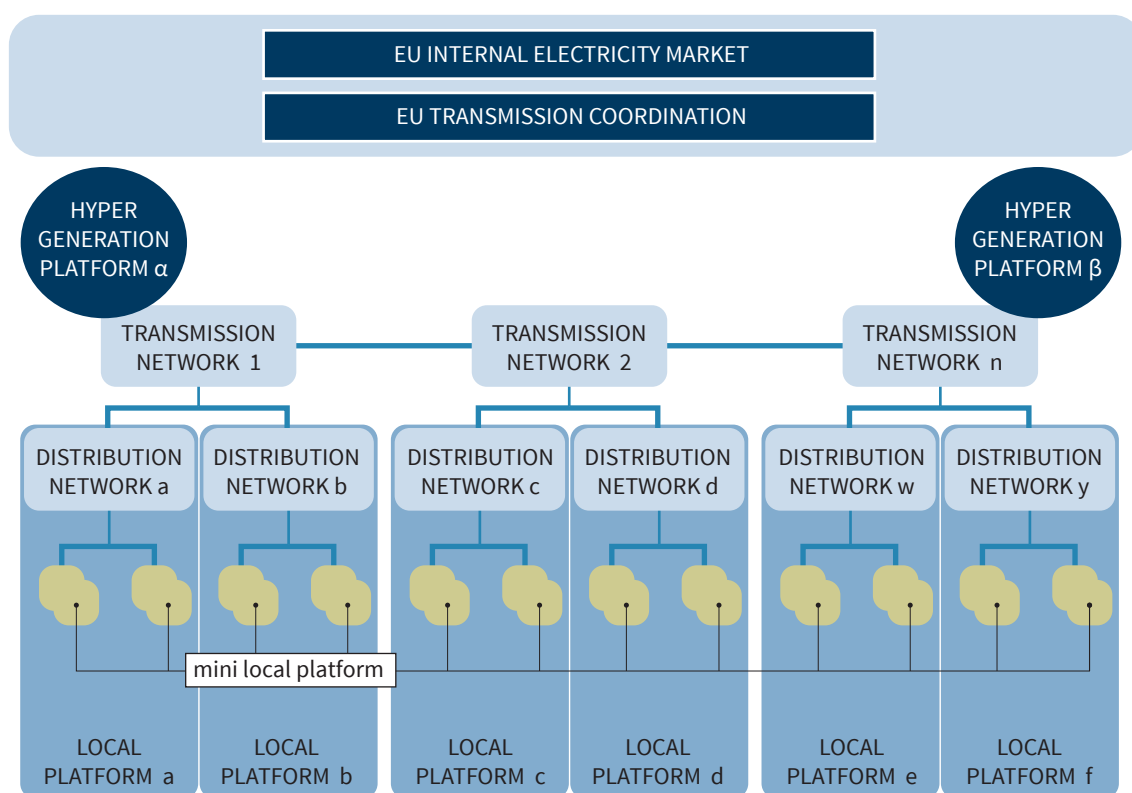
At this stage, local platforms are urgently needed for two main reasons:

1. To ensure efficient coordination of local energy resources, avoiding potential inefficiencies and even collapse of the local energy system caused by unpredictable, uncontrolled, potentially conflicting behaviours of mini local platforms and digitally empowered end-users and prosumers. The local platform is, firstly, the conceptual *locus* where the investment plan for the local common good (infrastructure) can be – politically - discussed and negotiated; secondly, it hosts the operational local system control centre. This operational function is extremely important for the real-time management of rivalry conflicts in distribution networks, similar to the role traditionally played by transmission network operators in deciding who gets access to the network and who is “redispatched”. But there is an even more important and new aspect: handling unforeseen changes in electricity flows and electricity balances. The

degree of uncertainty introduced by the digitalisation of energy, especially when associated with the massive electrification of heating/cooling and mobility, with their respective storage facilities, represents a huge and unprecedented challenge for distribution network operators. It is highly probable that these unexpected changes in traditional electricity patterns, due to the new “digital flexibility”, will not occur at the same time and with the same intensity throughout a nation or a (large) region. They may even cancel each other out at this macro- or meso-scale, while within the confines of a given local platform, such variations may be catastrophic.

2. Participate in EU-wide coordination of platforms – including local and hyper generation platforms (see next figure).

Figure 34 | **EU electricity structure – future**



Energy system integration takes place mainly at the local level (cf. Part II - The local perspective). In the future, the Internal Electricity Market can no longer be the sole focus - because the focus is now on local energy system integration -, and no longer the integrative pivot - because physical assets and their respective control are now decentralised, blurring the boundaries between wholesale, retail and self-generation at local level.

Achieving the 2030 energy decarbonisation targets with the current Single Market model and with the current interconnected electricity network governance model is not feasible. Awareness of the need and urgency for new models is growing; for

example, in their recent report to the French government, Blanchard and Tirole recommend the creation of “a common electricity transmission and distribution system at European level” to support the coordinated European wide development of renewable sources, as well as the creation of a “true pan European energy market”¹⁷⁵. These and similar recommendations should be seriously examined at EU level, because a new reality needs to be “constructed” and “[t]here are options” to be discussed in a modern EU democracy.

By the way, Blanchard and Tirole also make another interesting suggestion: the creation of “an R&D organization specializing in green innovation”¹⁷⁶.

The importance of clean tech R&D should be emphasised here. In the early 1990s, following the liberalisation and, in several countries (notably the UK, France and Italy) the partial or total privatisation of the electricity sector, the research centres of the former incumbent utilities (namely CEGB, EDF and ENEL) were substantially downsized or even dismantled. Attempts to create a European electricity research organisation based on a network of the remaining centres failed. In 2003, unbundling requirements forced these utilities to further split the remaining research centres according to their focus on regulated (networks) or non-regulated, transmission or distribution activities, leaving some grey and some empty areas.

Through successive research programmes the EU has funded many relevant projects in the energy sector, while encouraging cooperation between university and industrial research centres in different Member States. However, the importance of a more systematic and institutional approach has been underestimated. Research organisations played an essential role in the 20th century¹⁷⁷ and would be extremely useful in accelerating the transition to new energy architectures.

However, it is important to recall that “energy system transformation does not simply involve the invention and subsequent adoption of new technologies but the wholesale reconfiguration of social and technical components across various dimensions (e.g. science, markets, politics, etc.)”¹⁷⁸.

Adapting the current EU wholesale electricity market model, transforming the monopolistic “Single Market” into a co-operative Internal Energy Market platform, enabling enhanced coordination *and* competition across Europe, requires research, discussion and negotiation. Because the need for change has been denied for too long, and climate urgency is growing, there has been little time for the necessary adaptation, and time constraints now require a hastier transition. This seems a characteristic of our times: “Today we live in a world that is very poor in interruption; “betweens” and “between-times” are lacking.”¹⁷⁹

175 Olivier Blanchard and Jean Tirole, *Les grands défis économiques*, Presses Universitaires de France, 2022. Pg. 98.

176 Ibid., pg. 102.

177 See, for instance: J. Bradford DeLong, *Slouching towards utopia. An economic history of the twentieth century*, Basic Books UK, London, 2022.

178 Matthew Hannon and Ronan Bolton, *Energy innovation and the sustainability transition*, in Alessandro Rubino, Alessandro Sapia and Massimo La Scala (eds.), *Handbook of energy economics and policy*, Academic Press Elsevier, 2021. Pg. 351.

179 Byung-Chul Han, *The Burnout Society*, Stanford University Press, 2015.

PART V

How to get EU energy prices under control?

16. SURPLUS ENJOYMENT

Electricity and natural gas prices in the EU are out of control. Many Member States have introduced various price control mechanisms in 2021 and 2022, and more short-term relief measures have also been implemented and are still in place¹⁸⁰, through additional price control solutions, such as price caps, as well as through public (i.e., taxpayers') subsidies to energy consumers. Very often, legislators act even knowing that they are unable to predict the impacts of the massive subsidies they approve¹⁸¹. Almost everyone agrees that price controls are undesirable in principle and, as *extrema ratio*, should be used as little as possible. The question is how to get prices under control – now (through price controls), and later on, when current price controls are removed.

Before considering how to get “prices under control without price controls”, i.e., to create an ideal situation where no one (legislator, regulator or anti-competitive cartel) controls energy prices and yet they are under control, it is important to discuss how they got out of control in the first place. These two questions are addressed in the present chapter.

Losing control

“Surplus enjoyment. A Guide for the Non-Perplexed” could be the title of a new book for energy CEOs. Instead, it is the title of the latest book by Slavoj Žižek (described by the *New Yorker* as the *“Master of the counterintuitive observation”*). This book is (mostly) about Hegel, not about energy. In fact, energy is mentioned only once, and the reference isn't particularly original. Nevertheless, the book offers interesting stimuli to understand the current situation of “excess revenues” in European energy markets – a situation clearly enjoyed by shareholders, suffered by consumers, and observed without perplexity by those who believe that this is how “The Market” behaves (they should indeed first read Hegel on why, in exceptional circumstances, public authority should fix prices for *“the commonest necessities of life”*). This Section is a very brief attempt to guide the Perplexed through the current energy price mess.

In physical terms, Europe as a whole doesn't have a surplus of energy: the EU-27's overall energy dependence reached 60.5% in 2019, up from 50.0% in 1990. At an individual level, only Denmark (between 1999 and 2013) and the UK (between 1993 and 2003) enjoyed a total energy surplus for some years. Norway is the only exception: firstly, because it is not a member of the EU and, secondly, because it consistently exports annual quantities equivalent to between 4 and 8 times its total internal energy demand.

In 2005, for the first time after many years of self-sufficiency, domestic natural gas production was insufficient to meet all UK demand. The event was traumatic and the subject of intense public debate – *The Times*, for example, wrote on 23 November 2005:

¹⁸⁰ Cf. “ACER's inventory of 400+ energy emergency measures seeks to aid policy makers going forward”, and ACER, “Wholesale Electricity Market Monitoring 2022. High-level Analysis of Energy Emergency Measures”, March 2023. https://www.acer.europa.eu/Publications/Electricity_MMR_2022-Emergency_Measures.pdf

¹⁸¹ This is the case namely in Germany, the country with the most expensive and expansive gas and electricity consumer subsidies programme, as explained, for instance, in *Das Paradox der Gaspreise*, Frankfurter Allgemeine Sonntagszeitung, 23.02.05. Pg. 25.

“Just as Lenin wanted to build socialism in one country, Britain sought to build a free deregulated energy market in a single European state. It was a less vainglorious ambition, but no less futile. The British daydream of a sheltered market of perfectly priced megawatt hours is ending as fast as the hydrocarbon molecules are sucked out of the depleting North Sea reservoirs. From the gas glut of the mid-1990s, we have moved to the tyranny of the marginal molecule.”

Switching status from gas exporter to gas importer prompted the UK, which held the presidency of the Council of the EU in the second half of 2005, to promote the development of *“a common European energy policy.”* The rationale was quite simple: *“For far too long we have been in the situation where, in a haphazard and random way, energy needs and energy priorities are simply determined in each country according to its needs, but without any sense of the collective power we could have in Europe if we were prepared to pool our energy and our resources. This should focus, not on new regulatory barriers, but rather on obtaining a genuinely open energy market. It should deal with, for example, a properly integrated European Union grid”* (UK prime-minister’s speech at the European Parliament on 26 October, 2005). As a result, the European Commission issued a Green Paper in 2006, followed in 2007 by the Communication *“An Energy Policy for Europe”* - not anymore a *“common European energy policy”*: [Send and Archive](#).

Back in 2005, the most Eurosceptic of the EU Member States, distressed by the loss of its gas surplus status, proposed a common European energy policy - and the other Member States, addicted to perennial and growing energy deficits, repelled the proposal, rejecting the joy of building together a more secure energy Union. It turned out to be a costly missed opportunity – for both sides.

Surplus daydreams die hard - on 6 October 2022, the British Prime-Minister wrote in *The Times*: *“We must usher in a new era of European energy independence, dramatically accelerating our own energy production. (...) We are ready to work with our European friends to develop next-generation interconnectors in the North Sea. And I hope to make progress towards new partnerships on offshore wind, all of which will help to make the UK a net energy exporter by 2040.”* UK energy dependency is currently 38%.

Žižek’s view is that in our society excess, the superfluous, is necessary in order to identify the right quantity, i.e., one’s actual needs; therefore surplus (excess) is the perverse condition for enjoying the satisfaction of these basic needs. In the EU’s energy *“topsy-turvy world”* (Hegel), it seems that in the recent past, the more the deficit increased, moving countries away from a healthy equilibrium, the more one became dependent on foreign suppliers, the more one enjoyed - perversely - this kind of oppression; in the energy world, surplus seems to have a pathological nature, as literally illustrated by the *“Dutch disease”*; only deficit and alienation provide a *“gain of pleasure”* (Freud) – at least, until supplies are interrupted or prices skyrocket.

As Žižek reminds us, Freud teaches that *“what is repressed returns in a distorted form”*. In the case of the EU’s energy markets, the main repressed figure has been the long-term: long-term private contracts, long-term planning, long-term security of supply... For market fundamentalists, the long-term was considered as old-fashioned and as

welfare-destroying as any other State intervention. Over the last 30 years, the long-term has been repressed by EU energy policy, by the application of EU competition law to energy, by the energy *intelligentsia* and by energy consumers whenever spot energy prices were more convenient than guaranteed long-term prices. The EU energy crisis of 2022 rehabilitated long-term contracts¹⁸², after COVID-19 had already rehabilitated State intervention in general, in 2020¹⁸³. The speed and scale of this return of the repressed, particularly in terms of the volume of highly distorting national subsidies to energy consumers, was (politically, legally and financially) unimaginable just two years ago. But before we look at the current distortions, let's look at the repressions of the past.

Short-term enjoyment

Repressing the long-term and laying the short-term as the foundation of natural gas markets in Europe is understandable from a historical perspective – for decades, gas supply was a monopoly based exclusively on long-term contracts, and most of these contracts contained clauses and restrictions that were incompatible with free cross-border energy flows. In theory, long-term contracts were allowed – as the 2009 gas directive states, *“Long-term contracts will continue to be an important part of the gas supply of Member States and should be maintained as an option for gas supply undertakings in so far as they do not undermine the objective of this Directive and are compatible with the Treaty, including the competition rules”*¹⁸⁴. In practice, anything long-term was suspected of undermining the liberalisation project.

At the onset of gas liberalisation, it was necessary to “free up” infrastructure capacity for new players and new transactions, and this took a long time; as ACER pointed out in a press release on 1 September 2020¹⁸⁵: *“compared to the end of 2019, 20% of EU gas transportation legacy contracts’ volume will expire by the end of this year, while 60% will expire in 2028 and almost all legacy capacity will cease to exist by 2035. This implies that much more capacity will become available for the market, with bookings depending more than in the past on market conditions.”* However, the EU decided to go beyond mere capacity liberation, moving towards short-termism, as clearly expressed in the same press release: *“Since the implementation of the EU capacity allocation mechanisms network code prescribing standardised bundled products sold through open*

182 E.g., “Long-term renewables power purchase agreements should be encouraged. They can provide benefits both to industrial electricity users and renewable power producers. (...)The Commission will work with Member States to facilitate a wider market for decarbonised power purchase agreements”. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, *Tackling rising energy prices: a toolbox for action and support*, COM(2021) 660 final of 13.10.2021.

183 As regards State intervention following the energy price crisis, the Commission indicates that:
- “international cooperation on the supply, transport and consumption of natural gas can help keeping natural gas prices in check” (Ibid.);
- “price regulation and transfer mechanisms to help protect consumers and our economy are possible” (Ibid.); “Member States can consider temporary tax measures on windfall profits” Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of The Regions, *REPowerEU: Joint European Action for more affordable, secure and sustainable energy*, COM(2022) 108 final of 08.03.2022

184 Whereas 42, Directive 2009/73/EC of 13 July 2009. Also article 32.3.

185 <https://extranet.acer.europa.eu/Media/News/Pages/ACER-assesses-that-most-long-term-contracts-for-gas-transportation-in-Europe-will-expire-in-the-next-ten-years.aspx>

auctions, the market trend is to book shorter-term capacity products (up to one-year ahead), with limited volumes booked for longer durations. Given the current global gas markets conditions, network users seek to pursue as much flexibility as possible, while avoiding lock-in effects.”

Moreover, even the new “long-term” (i.e., 1 year) contracts are (or should be) hub-indexed, as another ACER document points out: *“Hub-based pricing and the shift away from oil-indexed long-term gas contracts has yielded significant benefits for Europe the past decade. Market integration facilitates structural supply competition and improves security of supply to the benefit of EU gas consumers. Since 2010, the development of increasingly liquid and competitive organised gas trading hubs has allowed both gas producers and consumers to gradually abandon the bilateral contracting of gas on a long-term oil-indexed basis, instead using hubprice indexes or even contracting gas volumes directly on spot and forward markets. According to the International Gas Union, that adaptation has entailed a share of hub-price based imports of more than 80% on average across Europe today, which is a percentage circa three times higher than in 2010.”*¹⁸⁶

The attempt to build an internal gas market based predominantly on spot prices was a mistake for two main reasons:

1. Unlike the USA, the largest gas producer country, accounting for 23% of total world production in 2021¹⁸⁷, with around nine thousand independent oil and gas companies¹⁸⁸, the EU relies on gas imports and its gas import dependency increased from 66% in 2000 to 90% in 2019. In 2019, 41.3% of gas imports came from Russia, accounting for 37% of the EU’s total gas supply. The second supplier (Norway) covered only 14% of total EU gas supply and the third one (Algeria) 7%. In other words, the EU gas market was largely dominated by Gazprom, with a share of 37%, compared to an aggregate share of 10% for all EU gas producers¹⁸⁹. While in the USA gas markets are organised through physical hubs, with clear transport and storage constraints, in Europe gas trading is organised through less transparent virtual hubs. For all of the above reasons, it was not a very wise decision to increase reliance on the spot market while import dependency and the market power of the dominant supplier steadily increased.
2. When the first gas liberalisation directive was adopted, in 1998, EU-27 gas production was 161 bcm; ten years later it had fallen to 148 bcm and in 2018 to 79 bcm (in 2020 it was only 56 bcm). Imports rose steadily from 251 bcm, in 1998, to 384, in 2008 and to 405 bcm in 2018. Demand was 362 bcm in 1998, 439 bcm in 2008 and 400 bcm in 2018 (in 2019, when all-time low gas prices were recorded, demand was only 411 bcm). In fact, gas demand peaked at 446 bcm in 2010 and has been declining ever since¹⁹⁰. This trend needs to accelerate, and natural gas

¹⁸⁶ ACER/CEER *Annual report on the results of monitoring the internal electricity and natural gas markets in 2020*, November 2021, pg. 8.

¹⁸⁷ <https://www.forbes.com/sites/rriapier/2022/07/25/us-natural-gas-production-set-a-new-record-in-2021/?sh=441981a516ac>

¹⁸⁸ <https://www.ipaa.org/independent-producers/>

¹⁸⁹ European Commission, *EU energy in figures. Statistical Pocketbook 2021*, September 2021.

¹⁹⁰ All data from Eurostat, referring to EU-27 2020.

must be phased out for the EU to meet its carbon neutrality goals. The “gas exit” needs to be negotiated with foreign suppliers to ensure fair conditions for both parties during the transition period of declining gas demand and gas trade.

Some early expert warnings were ignored, such as the following one from 2011:

*“In a very short period, we are moving from very long-term, 25 years and above, to very short-term capacity services, up to interruptible intra-day capacity services. While this move towards shorter term services is in many ways welcomed as it allows for new competition to emerge, the rationale and the nature of natural gas business should not be forgotten. Clearly, short-term capacity is necessary for competition and development of the markets. However, it is equally clear that long-term capacity is necessary for investments and security of supply. There is a need to consider and take into account the long-term nature of the natural gas business.”*¹⁹¹

Short-termism has also guided the construction of the internal electricity market. In January 2007, DG Competition’s final report issued a clear warning against long-term contracts: *“The Sector Inquiry has also confirmed the vertical tying of markets by long-term downstream contracts as a priority for review of case situations under competition law and for providing guidance where required. When such contracts, concluded by dominant firms, foreclose the market, Article 81 or 82 EC may be infringed unless there are countervailing efficiencies benefiting consumers. Similarly, power purchase agreements in the electricity sector can have foreclosure effects.”*¹⁹²

In line with the conclusions of the Sector Inquiry and similar to the 2009 gas directive, the 2009 electricity directive established that it is the duty of regulatory authorities to respect *“contractual freedom with regard to interruptible supply contracts and with regard to long-term contracts provided that they are compatible with Community law and consistent with Community policies”*^{193 194}. In practice, regulatory authorities followed the Commission’s view that long-term contracts were incompatible with energy policy and posed a high risk of market foreclosure. Later, DG Competition imposed the abolition or at least the severe restriction of interruptible contracts (which were based on long-term assumptions), in clear contradiction with Whereas (41) of the electricity directive: *“Member States or, where a Member State has so provided, the regulatory authority, should encourage the development of interruptible supply contracts”*.

Short-termism dominates the electricity sector. As long as there was overcapacity in electricity generation (mainly due to nuclear and natural gas power plants), there was no urgent need for policymakers to address long-term issues. Around 2011/2012, however, two important changes took place:

- On the one hand, owners of combustible fuel power plants started to retire capacity

¹⁹¹ K. Talas, *Long-term natural gas contracts and antitrust law in the European Union and the United States*, The Journal of World Energy Law & Business, Volume 4, Issue 3, September 2011.

¹⁹² European Commission, Communication from the Commission, Inquiry pursuant to Article 17 of Regulation (EC) No 1/2003 into the European gas and electricity sectors (Final Report), COM(2006) 851 final.

¹⁹³ Article 37 1l), Directive 2009/72/EC of 13 July 2009.

¹⁹⁴ This is the only reference in the whole directive to long-term contracts. The 1996 and 2003 electricity directives include no mention at all to long-term contracts.

as these plants were not profitable, due to low wholesale electricity prices¹⁹⁵. Total installed combustible fuel electricity generation capacity peaked at 426 GW in 2012 and has been declining since then¹⁹⁶, representing a loss of 38 GW by 2020.

- On the other hand, Germany decided to phase out nuclear, shutting down 20.5 GW installed nuclear electricity generation capacity¹⁹⁷.

Together, these two processes represent a loss of 7% of total installed capacity in 2011. Moreover, this was firm capacity.

Some Member States have responded by introducing so-called capacity remuneration mechanisms¹⁹⁸ to ensure the adequacy of installed generation capacity to expected demand, with various *ad hoc* schemes being approved by the European Commission. Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity (recast)¹⁹⁹ attempted to introduce some coherence, by, for example, determining that “*Before introducing capacity mechanisms, Member States should assess the regulatory distortions contributing to the related resource adequacy concern*” and establishing “General principles for capacity mechanisms” (Article 21) and “Design principles for capacity mechanisms” (Article 22). This Regulation, which mentions the word “capacity” 359 times and the word “adequacy” 88 times²⁰⁰, also provides the following definition (Article 2):

“ ‘capacity mechanism’ means a temporary measure to ensure the achievement of the necessary level of resource adequacy by remunerating resources for their availability, excluding measures relating to ancillary services or congestion management “.

The belated recognition of the importance of coordinated long-term analysis and investment has not yet produced concrete results. In fact, both the first (2021) and the second (2022) “European Resource Adequacy Assessment”, submitted by ENTSO-E, were not approved by ACER.

¹⁹⁵ For instance, in Germany, the average wholesale electricity price decreased from 45 €/MWh in the period 2004-2011 to 35 €/MWh in the period 2012-2019. Source: <https://www.mercatoelettrico.org/En/Statistiche/ME/BorseEuropee.aspx>

¹⁹⁶ Source: Eurostat.

¹⁹⁷ A first reduction, from 20.5 GW to 12.0 GW, took place in 2011/2012, with successive incremental reductions from 2013 until 2023, when the last nuclear power plants were shut down. Source: Eurostat.

¹⁹⁸ Cf. https://energy.ec.europa.eu/topics/markets-and-consumers/capacity-mechanisms_en

¹⁹⁹ OJEU L158 of 14.06.2019

²⁰⁰ The 2009 Electricity Directive mentioned the word “adequacy” just once (“That network development plan shall contain efficient measures in order to guarantee the adequacy of the system and the security of supply” – Article 22.1).

Marginalism and windfall profits

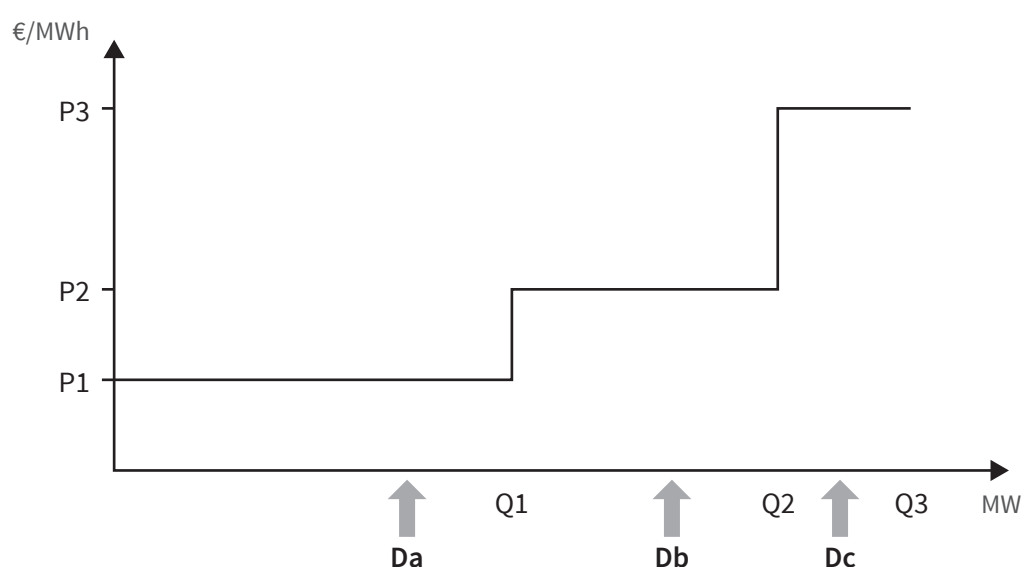
The following figures attempt to illustrate:

- how windfall profits are generated in the current EU wholesale electricity market;
- how they should have been (at least partially) avoided and
- why the current market model is inimical to decarbonisation and windfall profits are counterproductive.

For the sake of simplicity, no formulae are used here, only very basic concepts.

The next figure describes a simplified electricity market consisting of three types of power plants (type 1, 2 and 3), each type corresponding to a certain amount of installed capacity (Q_1 , $(Q_2 - Q_1)$ and $(Q_3 - Q_2)$ MW respectively) and to a certain marginal price (P_1 , P_2 and P_3 €/MWh respectively).

Figure 35 | Simplified wholesale electricity market - price mechanism



Three different time periods are considered, corresponding to different levels of demand:

- **Low demand**

When the total electricity demand is D_a , i.e., less than Q_1 , only some of the cheapest power plants (type 1) will run to meet this demand; the wholesale electricity price is P_1 and power plants of types 2 and 3 do not run, hence do not receive any money from the market.

- **Medium demand**

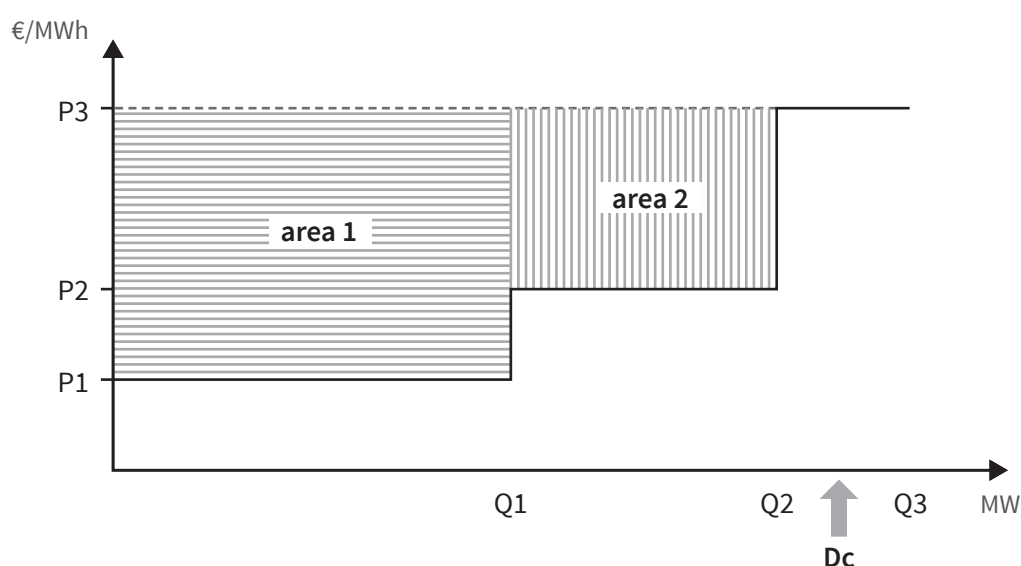
When demand increases to D_b (any value between Q_1 and Q_2), all type 1 and some type 2 power plants must run to meet demand; the wholesale electricity price is P_2 , the same paid to all running generators, and type 3 power plants do not receive any money from the market.

- High demand

Finally, if demand continues to rise to D_c (any value between Q_2 and Q_3), some type 3 power plants must also run to guarantee that all demand is met; the wholesale electricity price is now P_3 and all running generators receive this amount for each MWh injected into the grid.

Typically, type 1 power plants (e.g., wind and solar) have high investment costs and low variable costs; therefore, when they are running alone (i.e., during low demand periods), they are not able to recover their full costs. However, the amount of money they receive during periods of medium and high demand allows full cost recovery and a ‘fair’ profit – assuming the market is competitive – see next figure. Areas 1 and 2 correspond to the so-called “inframarginal rents” earned by generators type 1 and 2, respectively.

Figure 36 | Simplified wholesale electricity market – inframarginal rents



On the other hand, type 3 power plants typically have low investment costs and high variable costs (e.g., gas-fired power plants); because they run only a few hours per year (i.e., during periods of high demand), the market price during these hours must be high enough for them to recover full costs and earn a ‘fair’ profit. Again, in a competitive market, the price P_3 will provide the right remuneration to all generators. In a perfectly competitive market, social welfare is optimized in this way – i.e., the sum of producer and consumer surplus is maximised.

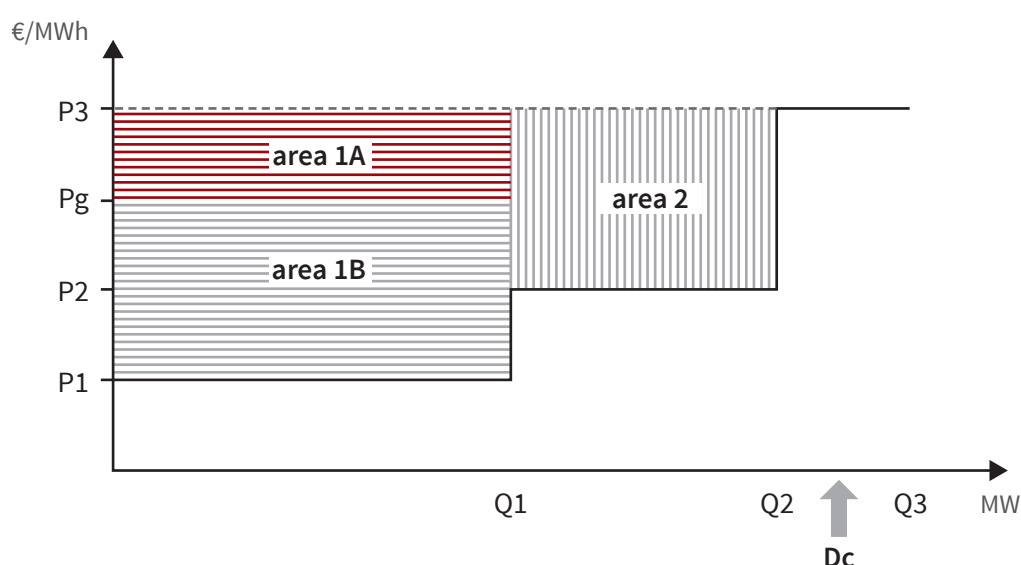
The ideal model described above has been partially abandoned by most Member States, many years ago, when they decided to introduce a guaranteed price for some generators, namely those using renewable energy sources. Initially, this guaranteed price was set by law (“feed-in tariff” or similar arrangements), but later it was determined by auctions – the so-called “competition for the market” process, instead of

“competition in the market” as described in the ideal model above. These new guaranteed-price generators simply want to run because the price they receive for each MWh fed into the grid is independent of the market price, so, they usually bid at or close to zero €/MWh.

Today, in several Member States, the installed capacity enjoying a guaranteed price represents more than 50% of the total installed generation capacity. For example, in Germany, at the beginning of 2023, installed renewable (wind, solar and biomass) capacity with a guaranteed price amounts to 144 GW²⁰¹, out of 232 GW²⁰² total installed capacity – i.e., 62%²⁰³. The 144 GW of renewable generation capacity corresponds to 2.8 million power plants.

In a mixed market, where “competition for the market” is combined with “competition in the market”, the situation should be different from the one depicted in the previous figure. Assuming that the average guaranteed price lays between P_2 and P_3 , the situation is shown in the next figure. Generators with a guaranteed price are entitled to the price P_g , not P_3 ($P_3 > P_g$). Of course, if demand is lower (say, D_b – see Fig. 35), they will receive the same price P_g , although the wholesale market price will then be $P_2 < P_g$.

Figure 37 | Simplified wholesale electricity market – guaranteed price



However, some Member States did not adopt this symmetrical regulation, allowing generators to receive the full wholesale market price P_3 whenever it is higher than the

201 https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Energie/Unternehmen_Institutionen/ErneuerbareEnergien/ZahlenDatenInformationen/EEStatistikMaStRBNetzA.pdf?sessionid=10DD1E16825323BE64E925ACBA20C088?__blob=publicationFile&v=13

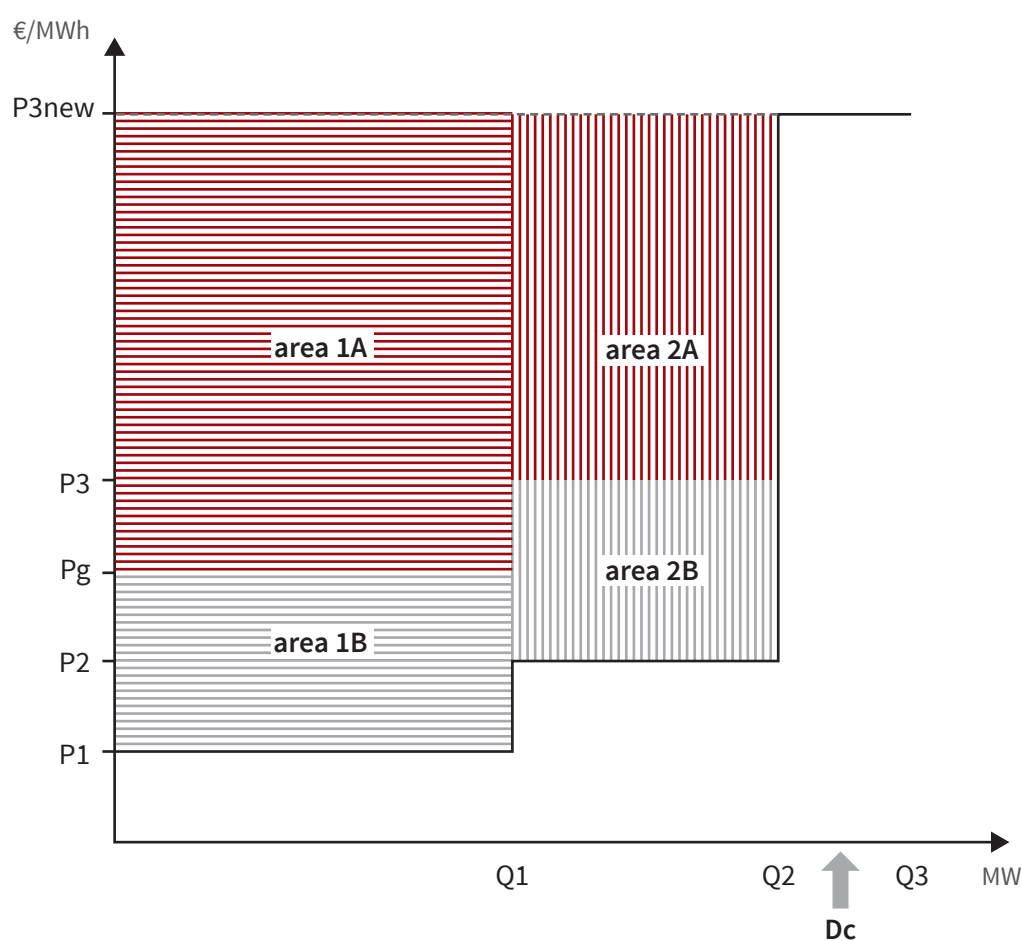
202 <https://www.smard.de/page/home/wiki-article/446/2362>

203 Given the relatively low utilisation factor of wind and solar power plants, the share of renewable subsidized electricity is lower than the share of subsidised capacity; in 2022, the combined share of wind, solar and biomass generation in Germany was 43% (<https://www.smard.de/page/home/topic-article/207548/209624>). In 2018 the share of subsidized renewable electricity was 30% (<https://www.ceer.eu/documents/104400/-/-/ffe624d4-8fbb-ff3b-7b4b-1f637f42070a>).

guaranteed price P_g . This situation, illogical and unfair under normal circumstances, became even more perverse during the energy price crisis, when the cost of gas-fired generation increased abnormally and $P_{3\text{new}}$ was much higher than P_3 – see next figure. The areas indicated in red - area 1A and area 2A - correspond to the so-called “windfall profits” for type 1 and type 2 power plants, respectively.

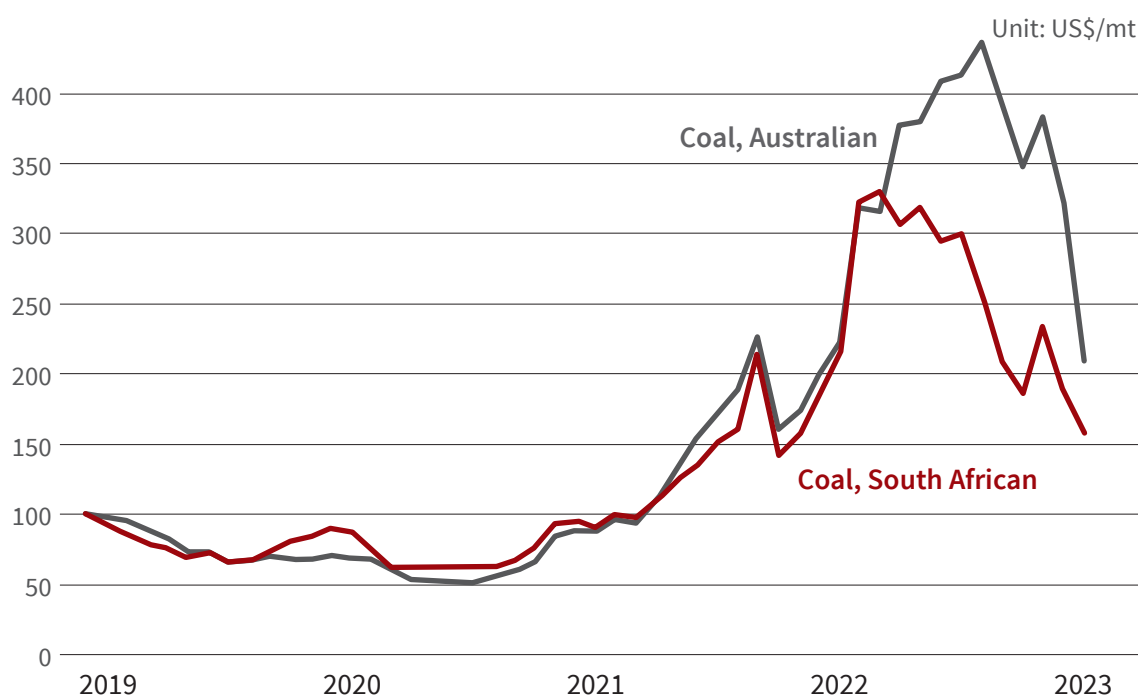
Gas price increases had no impact on the costs of type 1 power plants – their variable costs are close to zero (wind, sun,...) and their investments were sunk years ago. Moreover, they have a State guaranteed price and there is no economic (or other) reason to allow these generators to earn more than the amount fixed by law (feed-in tariff or similar) or by the auction they won. If the law was silent or permissive in this respect, the law should have been changed to avoid the existence of these windfall profits. The argument that the public authorities were not in a position to evaluate these windfall profits is not valid because for many years, whenever the guaranteed price was above average market price, public authorities (or those to whom they delegated the task) computed the amount of compensation to be paid to these generators by electricity consumers and/or taxpayers. The existence of these windfall profits is a shocking political failure.

Figure 38 | Simplified wholesale electricity market – windfall profits



Windfall profits associated with type 2 power plants are not so easy to compute because there is no guaranteed price to take as a reference. In Fig. 38 the P3 price has been used as a baseline to distinguish between the pre-crisis inframarginal rent (area 2B) and the crisis generated windfall profit (area 2A). However, while this is acceptable for nuclear power plants, it is not necessarily correct for coal-fired power plants, because coal prices were anomalously high in the second half of 2021 and in 2022, as shown in the next figure²⁰⁴. In “normal times”, variable costs represented around 40% of the total cost of a coal-fired power plant; in 2022, this figure was much higher for generators purchasing on the coal spot market due to higher coal prices. Therefore, the actual windfall profit was lower than area 2A shown in Fig. 38.

Figure 39 | **International coal prices, 2019-2023**



Note: Monthly data, last observation is February 2023

Source: World Bank

Why is the current market model inimical to decarbonisation and why are the windfall profits described above counterproductive? According to the economic theory underlying the EU wholesale electricity market, the wholesale price signal should guide generation investment in terms of 1) the type of power plants and 2) the amount of capacity, ensuring that enough capacity is installed to meet future demand at a reasonable cost. However, public policy in the EU severely restricts the freedom of investors by requiring electricity to be carbon-free; therefore, no new fossil fuel power plants should be built regardless of price signals. Investment will not be driven by price signals – in fact, it has not been driven by price signals for a long time, because Member States determine which types of power plants shall be built,

²⁰⁴ World Bank, <https://blogs.worldbank.org/opendata/declining-coal-prices-reflect-reshaping-global-energy-trade>

organising auctions as imposed first by the European Commission's Directorate-General for Competition²⁰⁵ and later by EU legislation²⁰⁶.

EU legislators innocently saw no problem in combining “competition for the market” with “competition in the market”, declaring the latter superiority with great ideological zeal: *“Support schemes for electricity from renewable sources shall be designed so as to maximise the integration of electricity from renewable sources in the electricity market and to ensure that renewable energy producers are responding to market price signals and maximise their market revenues.”*²⁰⁷ This view seems to ignore that integrating more renewable sources into the electricity market means increasingly reducing (liquidity of) “the market”, towards zero – see next paragraph. The faster electricity is decarbonised, the more “market price signals” become weak, volatile, meaningless and ultimately misleading. The postulate of *“integration of electricity from renewable sources in the electricity market”* was an absurd contradiction in terms, a kind of pyromaniacal positive feedback loop.

Since 2012, the installed capacity of combustible fossil power plants in the EU-27 has decreased significantly – i.e., the volume of retirements has been much higher than the volume of new additions (see Fig. 5). At the end of 2021, combustible fossil power plant capacity was 328 GW, almost the same as in 2005 (330 GW) and much lower than

205 Communication from the Commission *Guidelines on State aid for environmental protection and energy 2014-2020* (2014/C 200/01), OJEU C200 of 28.6.2014:

“(109) Market instruments, such as auctioning or competitive bidding process open to all generators producing electricity from renewable energy sources competing on equal footing at EEA level, should normally ensure that subsidies are reduced to a minimum in view of their complete phasing out.”

“(123) Aid to electricity from renewable energy sources should in principle contribute to integrating renewable electricity in the market. (...)”

“(124) In order to incentivise the market integration of electricity from renewable sources, it is important that beneficiaries sell their electricity directly in the market and are subject to market obligations. The following cumulative conditions apply from 1 January 2016 to all new aid schemes and measures:

(a) aid is granted as a premium in addition to the market price (premium) whereby the generators sell its electricity directly in the market; “

206 Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast), OJEU L328 of 21.12.2018, Article 4:

“1. In order to reach or exceed the Union target set in Article 3(1), and each Member State's contribution to that target set at a national level for the deployment of renewable energy, Member States may apply support schemes.

(...) with regard to direct price support schemes, support shall be granted in the form of a market premium, which could be, inter alia, sliding or fixed.

Member States may exempt small-scale installations and demonstration projects from this paragraph, without prejudice to the applicable Union law on the internal market for electricity.

4. Member States shall ensure that support for electricity from renewable sources is granted in an open, transparent, competitive, non-discriminatory and cost-effective manner.

Member States may exempt small-scale installations and demonstration projects from tendering procedures.

Member States may also consider establishing mechanisms to ensure the regional diversification in the deployment of renewable electricity, in particular to ensure cost-efficient system integration.

5. Member States may limit tendering procedures to specific technologies where opening support schemes to all producers of electricity from renewable sources would lead to a suboptimal result, in view of:

(a) the long-term potential of a particular technology;

(b) the need to achieve diversification;

(c) grid integration costs;

(d) network constraints and grid stability;

(e) for biomass, the need to avoid distortions of raw materials markets.

6. Where support for electricity from renewable sources is granted by means of a tendering procedure, Member States shall, in order to ensure a high project realisation rate:

(a) establish and publish non-discriminatory and transparent criteria to qualify for the tendering procedure and set clear dates and rules for delivery of the project;

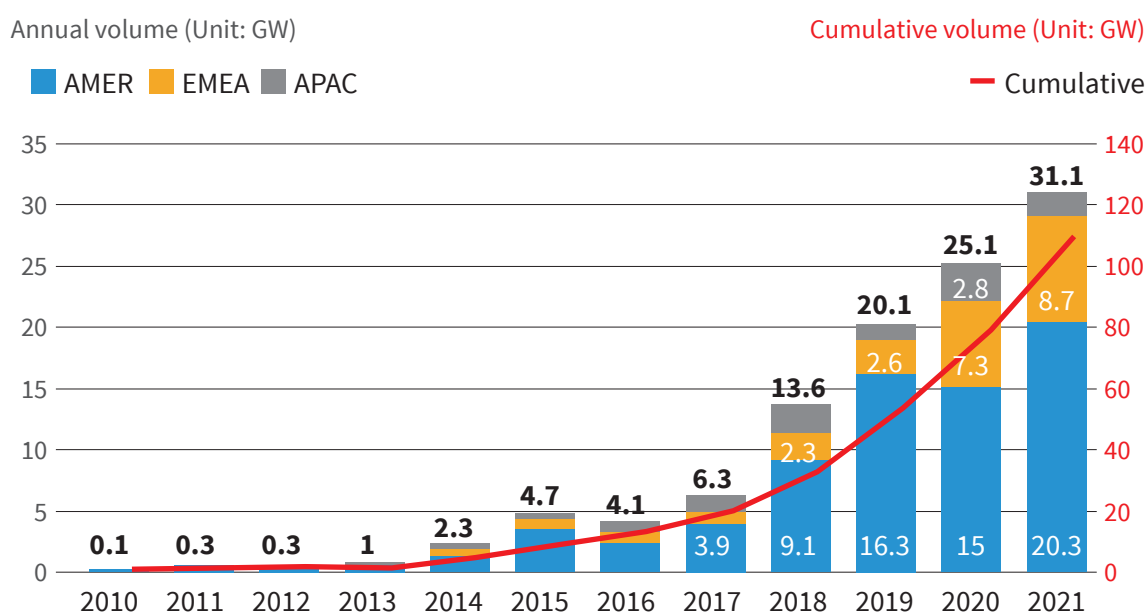
(b) publish information about previous tendering procedures, including project realisation rates.”

207 Ibid, Article 4, nr. 3

the peak reached in 2012 (383 GW) – a decrease of 14%. Over the same period, 2005-2021, installed wind capacity in the EU-27 increased from 38 GW to 188 GW and solar capacity increased from 2 GW to 164 GW²⁰⁸. In other words, over the last two decades more than 312 GW of wind and solar capacity was installed with guaranteed sales prices, while the amount of installed combustible fossil generation (exposed to market prices, i.e., without a guaranteed price) remained at 330 GW. From 2016, when the auctioning of support for renewables became mandatory, until 2021, 54 GW of wind and 73 GW of solar capacities were installed, while 28 GW of combustible fossil capacity was withdrawn from the market²⁰⁹.

Today, “in Europe, in many countries auction is the dominant way, through which new renewable electricity projects are deployed.”²¹⁰ Non-auction related capacities are local projects (mainly self-generation) and, more recently, private (or corporate) Power Purchase Agreements; these account for only 18.5 GW installed capacity (mainly in Spain, Sweden and Germany), as shown in the next figure²¹¹. The energy price crisis in 2021/2022 accelerated this trend in Europe. However, the lack of available network connection capacity, in general, and the lack of appropriate regulatory treatment, in some cases are slowing down this process.

Figure 40 | **Corporate clean power purchase agreement volumes by region, 2010-2021**



Note: Onsite PAs excluded. APAC volume is an estimate. Pre-reform PPAs in Mexico and sleeved PAs in Australia are excluded. Capacity is in MW DC.

Source: BloombergNEF.

²⁰⁸ Eurostat

²⁰⁹ In energy terms, instead of capacity, the Council of European Energy Regulators estimated that in 2018 the amount of subsidised renewable electricity represented 19.2% of total electricity generation in EU-28 plus Norway and North Macedonia - CEER, *Status Review of Renewable Support Schemes in Europe for 2018 and 2019*, C20-RES-69-04, 28 June 2021. Pg. 21.

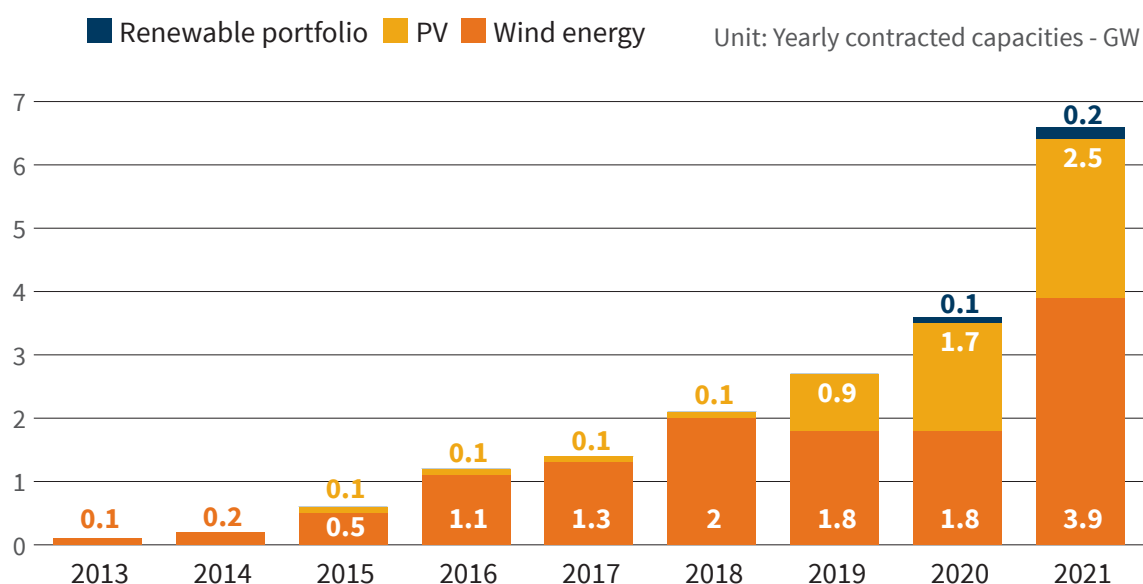
²¹⁰ European Commission, *Study on the performance of support for electricity from renewable sources granted by means of tendering procedures in the Union*, 2022. Pg. 67

²¹¹ Ibid.

This trend is visible not only in Europe, but also in the Americas, as shown in the next figure²¹² and confirmed by the IEA: “Procurement through PPAs, in which a corporate signs a contract directly with a power producer, is growing quickly worldwide”²¹³ because “corporates seek to maximise the visibility and additionality of their procurement efforts.”

As recognised by the European Commission, “[t]he rising importance of non-subsidized merchant project may put governmental auctions under great challenge. In a zero-support environment government auctions are not focusing on distributing support, but pursue other goals, such as the allocation of scarce grid connection points. Under these circumstances, if country level regulation allows, project promoters have the option to choose, whether they participate in tenders or choose merchant solutions. If PPA conditions are more favourable, the renewable auctions may become undersubscribed or empty.”²¹⁴

Figure 41 | **Total yearly contracted new PPA capacities in Europe**



Source: resource-platform.eu

In a recent assessment, the European Commission acknowledges that in spite of these challenges, auctions are here to stay²¹⁵:

“Looking forward, on the basis of the evidence from the performance of tenders in the past, it can be expected that tendering schemes may face some challenges and transformations in the future. (...) This means that tendering schemes will have to be adapted

²¹² Bloomberg, January 31, 2022. <https://about.bnef.com/blog/corporate-clean-energy-buying-tops-30gw-mark-in-record-year/>

²¹³ IEA, *Advancing Decarbonisation Through Clean Electricity Procurement*, Paris, 2022. Pg. 30.

²¹⁴ Ibid., pg. 68.

²¹⁵ European Commission, *Report from the Commission to the European Parliament and the Council on the performance of support for electricity from renewable sources granted by means of tendering procedures in the Union*, COM(2022) 638 final of 15.11.2022. Pg. 21.

to become complementary to or synergetic with renewable projects that are (partly) financed through PPAs.

Even if tenders might become less relevant in terms of financial support, they would however keep their strategic role as an instrument to effectively disburse scarce resources” (i.e., network capacity).”

The type of power plants and the respective amounts of capacity to be built are determined by Member States, mainly through the auctioning of generation capacity, either explicitly or implicitly, through the auctioning of network capacity. Very often, Member States also determine the location of new power plants (e.g., *offshore* wind farms). Spot market prices have not driven new generation investment in the last two decades and will not do so in the future. Indeed, the financing of new generation projects has been based on forecasts of wholesale market prices; but these forecasts have been systematically wrong (even before the unexpected – *ergo*, unforeseen... – 2021/2022 energy price crisis), and they will become increasingly irrelevant as more auction-based generation replaces old fossil fuel generation, reducing market liquidity. The forecasts are therefore *de facto* as useless as the underlying spot prices. It would be appropriate to face reality and to find a new, more realistic approach, rather than clinging to the fictions of an ideal world that ceased to exist many years ago, even as an imperfect approximation.

In the old, “ideal” market world, i.e., under conditions of perfect competition, infra-marginal rents, the difference between the market price and the power plant marginal cost, were the major incentive for investments in new power plants. To a large extent, they drove investment in combustible fuel power plants, which explains why 142 GW were added to the EU-27 electricity generation mix between 1990 and 2010. However, in the new context, new investment in fossil fuel power plants is no longer desired – in some countries not even legally possible. Therefore, allowing for the accumulation of infra-marginal rents and windfall profits to be diverted to other businesses is not a very rational approach – neither for market design nor for decarbonisation.

In conclusion: the EU energy price crisis was triggered by external factors (Russian war on Ukraine, global gas market situation, etc.), but it was amplified by internal factors, namely excessive short-termism in EU gas and electricity markets. The windfall profits of many electricity generators are unjustified and stem from a serious political failure - they could and should have been avoided. There is no reliable information on the size of such windfall profits, revealing a regulatory failure. Both failures should be addressed urgently through legislative and regulatory action.

Regaining control

Under conditions of perfect competition, markets ensure “prices under control without price controls”, i.e., the market itself is the self-control mechanism: according to equilibrium theory, the dynamics of supply and demand lead to the optimal equilibrium. However, even in the absence of exogenous shocks²¹⁶, markets rarely deliver such an optimal outcome. Moreover, if a given economic sector is supposed to undergo deep structural change in order to deliver some desired societal outcomes, like decarbonisation, the basic assumptions of the equilibrium theory do not hold and the probability of a self-regulating market is indeed very low. The faster the transition from initial state to desired new state, i.e., the faster the energy transition to decarbonisation and digitalisation, the harder it will be to keep electricity prices under control.

Rising energy prices and increasing energy price volatility should not stop the necessary transition to carbon neutrality. Therefore, building a new multi-sector and multi-level energy architecture remains a top priority. Within this framework, the problem of energy prices can be analysed at two different levels: local and EU.

At the local level, energy system integration leads to a whole new approach to energy, including pricing. Decentralised resources are usually associated with long-term contracts or with (long-term) individual investments. Therefore, different energy prices will emerge in different local energy platforms, reflecting different local demand patterns, different available natural resources, different energy system integration approaches, different local energy infrastructures, different trading and sharing arrangements, etc.. Local consumers, prosumers, suppliers and other energy agents not only decide on local investments and local policies, but also shape local platforms, thus establishing a direct link between their – individual and collective – decisions and energy prices.

At EU level, the question is how to change current wholesale electricity market rules to better protect consumers during the transition to 2030 and beyond, knowing that the current EU wholesale electricity market must evolve from a *de facto* monopolistic platform embodying a “Single Electricity Market” through which all electricity transactions must pass, to a platform of platforms, providing opportunities for voluntary transactions between both centralised and decentralised agents. Short-term changes to protect consumers should be aligned with this long-term structural objective.

Three key changes can be introduced now to better control wholesale electricity prices:

- 1.** What you agree is what you get
- 2.** Water is not for free
- 3.** Managed fossil phase-out

²¹⁶ On the recent energy price crisis see Alberto Clò, *Il ricatto del gas russo. Ragioni e responsabilità*. Il Sole 24 ORE, 2022. Alberto Clò was the Italian energy minister when Italy held the presidency of the Council of the EU in the first half of 1996; he was responsible for the political compromise concerning the first electricity liberalisation directive, officially approved in December 1996.

What you agree is what you get

This rule means that electricity generators with a guaranteed State sales price – as a feed-in tariff, auction outcome or equivalent mechanism - will be paid the agreed price, regardless of the wholesale market price. There is no reason why these generators should be allowed to make windfall profits, now or in the future (or, of course, in the recent past).

Water is not for free

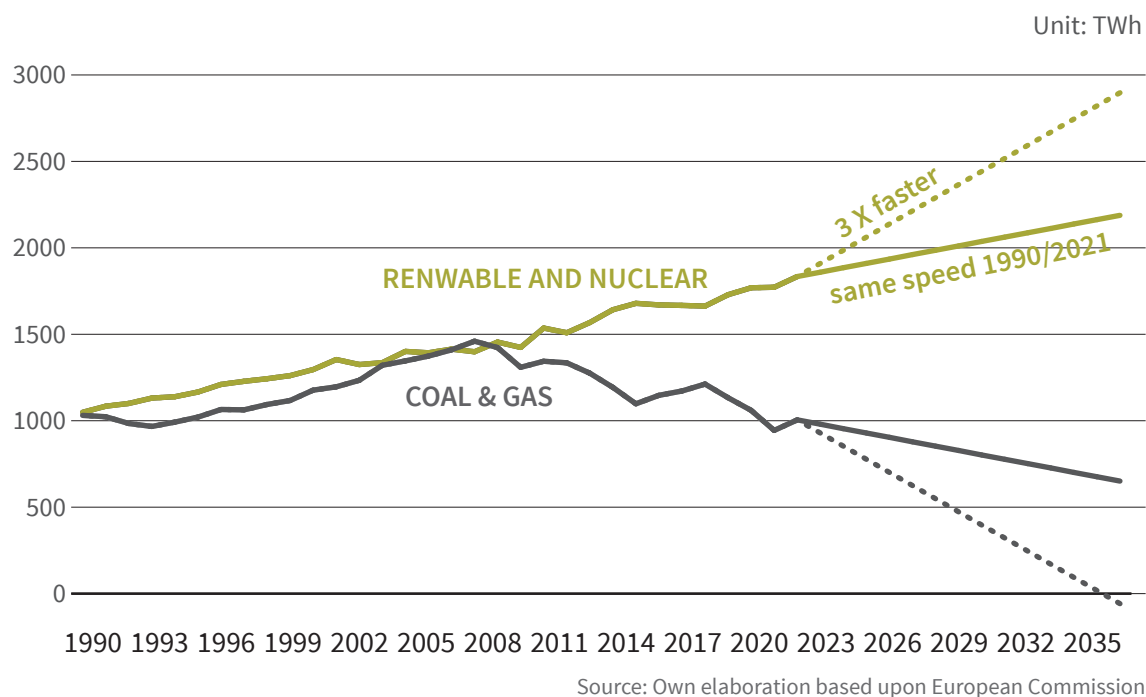
Hydropower is an important renewable electricity resource, especially when associated with storage capacity. However, water has multiple uses and is an increasingly scarce resource. As a result, the freedom of hydropower generators is already constrained by social and economic, as well as environmental, considerations. While other forms of energy storage are not widely deployed, owners of hydropower plants enjoy a particularly important dominant position. During the energy transition, a price cap could be imposed on hydroelectricity and pump storage could be placed under public management, for instance by TSOs, in order to optimise the overall system performance (higher penetration of renewable electricity, system stability, adequacy and security, etc.).

Managed fossil phase-out

This is the most difficult, but also the most important and most urgent of the proposed measures. To get a better idea of the scale and importance of this issue, please see the next figure ²¹⁷. It shows combined gross electricity generation from solid fossil fuels and gas (grey curve) and combined gross electricity generation from nuclear and renewables, including biofuels (green curve). From 1990 to 2021 these are historical data; from 2022 to 2035, they correspond to a linear extrapolation of historical data of nuclear plus renewable gross electricity generation (solid green) and an extrapolation at 3 times the speed (dashed green line). Fossil generation was assumed to decrease by the same amount as the additional nuclear plus renewable generation – and it is further assumed that demand remains stable. To fully decarbonise EU electricity generation by 2035 (no CCS considered), carbon neutral electricity generation will have to grow at three times the rate of the last three decades.

217 Own elaboration based upon European Commission, *Energy datasheets: EU countries*, update 27 April 2023

Figure 42 | Phasing-out fossil electricity generation



Taking into account the electrification of mobility and heating/cooling, the volume of electricity demand will increase significantly, as discussed in Ch. 0 Introduction. This will require a much faster deployment of renewable power plants than the curve shown in the figure above.

The possibility of complete decarbonisation of electricity generation depends on factors other than this simple algebraic exercise, namely an accurate system adequacy analysis. However, the picture above provides interesting insights, not only into the required pace of new construction and investment, but also into the pace at which fossil fuel power plants can be phased out of the system.

If fossil fuel power plants are to play this historic role in the EU's transition to carbon neutrality, they cannot be left with the perspective of diminishing sales depicted in the figure above, otherwise, within the current "Single Electricity Market" model, they would either shut down the plants or bid very high prices to avoid stranded costs. As neither of these outcomes is desirable, the phase-out needs to be properly managed, and this means negotiating prices with all or some of the fossil fuel power plants, and agreeing how these (guaranteed) prices will be passed on to consumers (or taxpayers).

Žižek observes that in the process of a passage from the old order to a new order some kind of mediation is needed, to guide thought and action, to help understand this transitional moment, because *"when the older order is disintegrating, unexpected things happen"*. However, *"[o]nce the new order is established, a new narrative arises and, within this new ideological space, mediators disappear from view."* This chapter in particular, and this report in general, attempts to be a kind of energy vanishing mediator.

17. IS SPAIN THE NEW ATHENS ?

Spain is credited with inventing the independent Transmission System Operator, back in 1984. The company fulfilling this role, Red Eléctrica de España, was created in 1985. Later, in 1987, a new legal framework for the Spanish electricity system was approved, known as the “Marco Legal Estable”²¹⁸; it was in force between 1988 and 1997, when liberalisation was introduced.

Essentially, the “Marco Legal Estable” provided generators with a guaranteed remuneration based on standard costs approved and regularly updated by the government. Obviously, the political definition of standard costs was a source of permanent dispute and litigation. This pre-liberalisation model has recently been proposed as a means of controlling prices during the current energy price crisis – or even afterwards...

This model is actually very old, having been proposed by Aristotle in *The Athenian Constitution*:

“Market Commissioners (Agoranomi) are elected by lot, five for Piraeus, five for the city. Their statutory duty is to see that all articles offered for sale in the market are pure and unadulterated.

Commissioners of Weights and Measures (Metronomi) are elected by lot, five for the city, and five for Piraeus. They see that sellers use fair weights and measures.

Formerly there were ten Corn Commissioners (Sitophylaces), elected by lot, five for Piraeus, and five for the city; but now there are twenty for the city and fifteen for Piraeus. Their duties are, first, to see that the unprepared corn in the market is offered for sale at reasonable prices, and secondly, to see that the millers sell barley meal at a price proportionate to that of barley, and that the bakers sell their loaves at a price proportionate to that of wheat, and of such weight as the Commissioners may appoint; for the law requires them to fix the standard weight.”²¹⁹

If we replace “barley” with natural gas, “barley meal” with electricity from natural gas power plants, “wheat” with wholesale electricity price and “loaves” with electricity retail price, the similarity between ancient Athens and modern Spain becomes apparent.

This model is also not very different from the approach used for many decades in the USA to regulate vertically integrated electricity monopolies, and it is still applied in some States, in the USA and in other geographies where electricity liberalisation has not been implemented, or has only been partially implemented.

The main drawbacks of “cost-of-service price regulation” are well known, and the disadvantages of this method are exacerbated when price regulation is exerted by government, through ownership or by command-and-control, rather than by an

²¹⁸ Red Eléctrica de España, *El Marco Legal Estable. Economía del sector eléctrico español 1988-1997*. <https://www.ree.es/sites/default/files/downloadable/marcolegalestable.pdf>

²¹⁹ Aristotle, *The Athenian Constitution*, 51. <https://www.gutenberg.org/files/26095/26095-h/26095-h.htm#part51>

independent regulatory authority²²⁰. Comparing investment costs of power plants of different sizes, built in different periods and in different locations, is a difficult task, even if the comparison is restricted to the same primary energy family. On the other hand, it is equally difficult to compare primary energy costs (coal, natural gas, oil products, uranium) that depend on international markets that are not always very transparent and where long-term bilateral contracts have been the rule. The assessment of both fixed and variable “fair and reasonable” electricity generation costs is indeed a challenging task, and this is one of the reasons why electricity generation was liberalised in the 1990s.

Although the application of the Sitophylaces model cannot be considered as a serious proposal for managing the energy transition, alternative models should also be subjected to a similar critical assessment. Perhaps reality is closer to the Athenian model than many of its critics imagine.

As noted in the Introduction to this report (see Fig. 7) and in the previous chapter, for almost 20 years almost all new electricity generation capacity built in the EU has benefited from a State guaranteed price. In 2021, combined wind and solar capacity accounted for 35% of total installed generation capacity. Hydroelectric generation capacity has increased by 16 GW between 2000 and 2021²²¹; although these power plants do not usually benefit from a State guaranteed selling price, European law requires hydropower authorisations and concessions to be awarded through “transparent and impartial selection procedures”²²². At the same time, the installed capacity of coal, gas and nuclear power plants has decreased: between 2011 and 2021, combustible fuels electricity generation capacity decreased by 10% (42 GW) and that of nuclear generation by 13% (16 GW)²²³. New nuclear power plants, under construction or planned, also enjoy a State guaranteed selling price or equivalent benefits. Most new renewable electricity generation projects, both onshore and offshore, are dependent on State managed auctions.

If in the year 2030 (or soon thereafter) all electricity is green (or zero-carbon, thus including nuclear), and if the vast majority of new electricity generation capacity is auctioned in our current “Single Electricity Market”, then the average cost of electricity in 2030 can be determined in advance: since variable costs are close to zero, it will

²²⁰ The benefits of independent price regulation were clearly described by USA President Theodore Roosevelt in 1905, when he addressed Congress, in the State of the Union message, pledging for a powerful independent railway regulatory agency: “(...) It is because, in my judgement, public ownership of railroads is highly undesirable and would probably in this country entail far-reaching disaster, that I wish to see such supervision and regulation of them in the interest of the public as will make it evident that there is no need for public ownership. The opponents of government regulation dwell upon the difficulties to be encountered and the intricate and involved nature of the problem. Their contention is true. It is a complicated and delicate problem, and all kinds of difficulties are sure to arise in connection with any plan of solution, while no plan will bring all the benefits hoped for by its more optimistic adherents. Moreover, under any healthy plan the benefits will develop gradually and not rapidly. Finally, we must clearly understand that the public servants who are to do this particularly responsible and delicate work must themselves be of the highest type both as regards integrity and efficiency. They must be well paid, for otherwise able men cannot in the long run be secured; and they must possess a lofty probity which will revolt as quickly at the thought of pandering to any gust of popular prejudice against rich man as at the thought of anything even remotely resembling subserviency to rich men. But while I fully admit the difficulties in the way, I do not for a moment admit that these difficulties warrant us in stopping in our effort to secure a wise and just system.(...)”

²²¹ European Commission, *Energy datasheets: EU countries*, update 27 April 2023

²²² European Commission, https://ec.europa.eu/commission/presscorner/detail/FI/IP_19_1477

²²³ European Commission, *Energy datasheets: EU countries*, update 27 April 2023.

essentially be the weighted average of the different contract prices corresponding to the different auctions (or equivalent State guarantees). In this “Single Electricity Market” scenario, the life of “Corn Commissioners” in 2030 will be much easier than in ancient Athens, because each “miller” (i.e., each power plant) must sell at the price agreed when the respective auction took place and “corn” (wind, sun, water, geothermal heat) is for free. In other words, the corn market vanishes and is replaced by a market in licenses (or authorisations, or concessions) for millers.

Apparently, this scenario is better than the Spanish “standard costs” model, because here there is no guesswork, no discretionary power in the hands of governments or regulatory authorities, since all prices are determined by competitive bidding. However, the strict application of auctioning leads inexorably to the Single Electricity Market death spiral...

Anticipating the desolating outcome of the equation “Single Electricity Market + Green Deal + Auctioning = fixed price”, some market designers are proposing creative ways of introducing some kind of uncertainty or volatility, for instance by creating a “Single Buyer” of long-term generation contracts, who resells capacity through different types of contracts, with different maturities, etc.. Apart from creating new business opportunities for brokers, the financialisation of electricity does not add value for energy consumers or for the energy transition (e.g., by facilitating technical innovation). It is just a way of introducing “artificial” competition.

An alternative to financialisation is the creation of local platforms where bilateral contracts for several energy-related products can be established among a diversified number of actors. At this level, electricity cost differences arise “naturally” not only because of different costs of capital, but also because of different business models and different ways of implementing - and practising - energy system integration. Diversification of energy-related products and energy cost differentials within a local platform area stimulate competition without jeopardising the possibility of entering into other types of transactions (e.g., sharing).

Taken literally, Aristoteles’s Constitution may not be the best model for modern, digitalised energy markets; but, as a reminder of the centrality of the city, it is a great source of inspiration for the organisation of democratic and efficient local energy platforms.

Accepting the centrality of the city in the energy transition towards 2030 and 2050 does not mean imposing the same model on all cities or regions. Diversity can and should be understood, accepted and managed within a supra-national legal system, as another distinguished Athenian expressed so clearly centuries ago:

“Next in order we shall have to legislate about the horse contests. Now we do not need many horses, for they cannot be of much use in a country like Crete, and hence we naturally do not take great pains about the rearing of them or about horse races. There is no one who keeps a chariot among us, and any rivalry in such matters would be altogether out of place; there would be no sense nor any shadow of sense in instituting contests which are not after the manner of our country. And therefore we give

our prizes for single horses—for colts who have not yet cast their teeth, and for those who are intermediate, and for the full-grown horses themselves; and thus our equestrian games will accord with the nature of the country.”²²⁴

It is to be hoped that, in the midst of the current energy horse-trading, EU legislators will not lose sight of this recommendation and support a coherent, polycentric, multi-sector and multi-level energy architecture that allows for different types of “contests” and widespread innovation.

²²⁴ Plato, *Laws*, Book VIII, https://www.gutenberg.org/files/1750/1750-h/1750-h.htm#link2H_4_0011

PART VI

Miscellaneous

18. EU ELECTRICITY NETWORKS OR THE TRAGEDY OF THE MISSING COMMONS

The “Tragedy of the Commons” is the title of a 1968 paper by Garrett Hardin discussing how unrestricted demand for a finite resource can lead to overexploitation and eventual resource depletion (“Freedom in a commons brings ruin to all”²²⁵). This is one of the most cited - and most criticised – papers ever. One criticism is that the existence of some commons for centuries proves that they can be self-organised in a sustainable way (some authors speak in this context of “the triumph of the commons” ...), so that no external intervention is needed to prevent ruin. This concept has been substantially elaborated by Elinor Ostrom who explained her point of view as follows:

“Instead of presuming that optimal institutional solutions can be designed easily and imposed at low cost by external authorities, I argue that “getting the institutions right” is a difficult, time-consuming, conflict-invoking process. It is a process that requires reliable information about time and place variables as well as a broad repertoire of culturally acceptable rules.

Instead of presuming that the individuals sharing a commons are inevitably caught in a trap from which they cannot escape, I argue that the capacity of individuals to extricate themselves from various types of dilemma situations varies from situation to situation.”²²⁶

Based on extensive empirical work, Ostrom shows that there is no *a priori* universal optimal institutional solution to a commons problem – the best solution depends upon the context, and it may be internal (self-organisation) or external (privatisation, regulation, etc.). On the other hand, the importance of combining technical and social knowledge is emphasised as follows:

“Without understanding both the social systems and the technical aspects of the management of a resource, we cannot conduct work that enables us to understand the conditions that help produce sustainable management.”²²⁷

This requires “developing a multidisciplinary, multi-tier framework for analysing sustainable social-ecological systems”, in particular “whether we need to impose institutions from outside” to generate sustainable outcomes.

The above-mentioned recommendations are extremely useful for the ongoing electricity reform process, as explained later in this chapter, even though electricity networks are not a common pool of natural resources like pastures, meadows, water basins or fisheries. Indeed, EU electricity network users, once they get connected to the network, enjoy non-discriminatory, regulated access to the “network resource”

225 Garrett Hardin, *The tragedy of the Commons*, *Science*, Vol. 162, No. 3859 (Dec. 13, 1968). Pg. 1244.

226 Elinor Ostrom, *Governing the Commons*, Cambridge University Press, 1990. Pg. 14. She adds: “Unfortunately, many analysts – in academia, special-interest groups, governments, and the press – still presume that common-pool problems are all dilemmas in which the participants themselves cannot avoid producing suboptimal results, and in some cases disastrous results.” (pg. 24).

227 Elinor Ostrom, *The future of the commons: beyond market failure and government regulation*, The Institute of Economic Affairs, London, 2012. Pg. 69.

and there is no risk of physical exhaustion of network capacity. However, as network capacity is limited, it has to be somehow allocated to users for individual transactions - the limited capacity of transmission lines in the interconnected network thus limits the freedom of users to engage in electricity transactions with other users. Whereas in natural resource commons physical access to the resource has to be controlled to avoid the risk of depleting the resource, in electricity networks access to the network has to be controlled because there is not enough network physical capacity – even though there is no risk of depleting energy (renewable) resources. In other words, while in natural resource commons access is limited to protect the sustainability of the resource, in electricity systems access is limited to protect, not the renewable natural resource (energy), but the integrity of the transport channel of the resource (the network) and the reliability and stability of the whole electricity system – a precious common good...

Regarding the governance of transmission networks during and for liberalisation, it is worth noting that some developments in the USA have been clearly more innovative and collaborative than in the EU, as explained in the following text:

“Through the ISO/RTO [Independent System Operator / Regional Transmission Organization] model, the collaborative-governance package has transformed governance in the electricity industry. Careful attention to the instrumental value of participation as well as its normative value is nowhere more important than in electricity governance. Indeed, collaborative problem-solving changes the conceptualization of the interaction among the interests. Electricity governance is a complex prisoner’s dilemma in which individual self-interest may in fact diminish the payoff for everyone, unlike most business relationships in which competition has social value. Mutual trust is obviously not enough and hence positive governance is necessary. The governance structure must be effective and fair-and appear to be effective and fair. The ISO/RTO model then serves the complex problem-solving challenges of the electricity industry. At the same time, it satisfies all the various interests in which they are involved in substance as well as form.

(...)

Those who have been involved with the U.S. electricity industry since before restructuring would say that the European Union is trying to do it the hard way. (...) The EU vision is at base federalized command-and-control regulation. This vision is the one the United States is trying to escape. The way out for the United States has been a shift to employing truly independent transmission-management bodies, which are governed in such a way as to force sensitivity to the interests of all the stakeholders. The various levels of regulators then become the monitors and ultimate guarantors of the public regarding performance. This approach would better answer the goals identified in the Commission’s third-package proposals.”²²⁸

While the ISO benefits described above may be somewhat exaggerated – their

²²⁸ Charles H. Koch Jr., *Collaborative Governance: Lessons for Europe from U.S. Electricity Restructuring*, Faculty Publications, 1270. 2009. William & Mary Law School Scholarship Repository. <https://scholarship.law.wm.edu/facpubs/1270>

performance depends on the specific approach to liberalisation taken in some States of the USA – the criticism of the European “hard” approach – meaning too rigid and excessively ideological – is well deserved. A similar difference between the quick and pragmatic North American approach and the rigid and ultimately ineffective EU approach was already observed back in 2003, when large-scale blackouts hit first the USA and then continental Europe, requiring a new approach to reliability^{229 230}. In fact, “There is no technical, economic or institutional justification – and there is indeed no empirical evidence – to make us believe that market forces can self-organise and self-regulate electricity reliability. Legislators could have allowed market forces alone to shape markets and, at the same time, provide a suitable legal framework to protect the ‘common good’ reliability, thus avoiding the potential risk of an impoverished technical quality of service, blackouts, etc.”²³¹

Electricity networks are not natural systems, nor are they like digital resources in general or communication networks in particular, although both networks are man-made and a finite resource. However, communications infrastructure is expanding quickly and providing access to digital resources (such as databases) around the world, thus giving the impression of infinitude²³², while electricity networks are growing slowly and have a limited reach: for example, Africa has more mobile-cellular telephone subscriptions than Europe (908 million versus 812 million, in 2021²³³) and 984 million people are covered by a mobile-cellular network²³⁴; however, 600 million people in Africa do not have access to electricity²³⁵.

Digital networks support multiple digital services and business models, whereas electricity networks have so far only carried electricity to “consumers”. The Internet has enabled the emergence of new production and management models that in some ways resemble the old commons, as Yochai Benkler and others have pointed out:

“Free software offers a glimpse at a more basic and radical challenge. It suggests that the networked environment makes possible a new modality of organizing production: radically decentralized, collaborative, and nonproprietary; based on sharing resources and outputs among widely distributed, loosely connected individuals who cooperate with each other without relying on either market signals or managerial commands. This is what I call “commons-based peer production.” “²³⁶

Of particular interest in the context of electricity reform within electricity digitalisation, is Benkler’s remark on some essential characteristics of organisational

229 Cf. Jorge Vasconcelos, *Security of energy supply: prophecies and fallacies*, 2nd Annual Conference, Florence School of Regulation, May 12, 2006.

230 Jean-Michel Glachant, Nicolò Rossetto and Jorge Vasconcelos, *Moving the electricity transmission system towards a decarbonized and integrated Europe: missing pillars and roadblocks*, European University Institute, 2017. Pg. 127/8.

231 Ibid., pg. 121

232 Of course, communication networks have finite bandwidth, as all Internet users know by experience, but it’s incredibly fast geographical expansion and speed growth creates the perception of a quasi-unlimited resource.

233 ITU, https://www.itu.int/en/ITU-D/Statistics/Documents/facts/ITU_regional_global_Key_ICT_indicator_aggregates_rev2_Sept_2022.xlsx

234 Ibid.

235 IEA, <https://www.iea.org/reports/africa-energy-outlook-2022/key-findings>

236 Yochai Benkler, *The Wealth of Networks: How Social Production Transforms Markets and Freedom*, Yale University Press, 2006. Pg. 60. Also available as Creative Commons at http://www.benkler.org/Benkler_Wealth_Of_Networks.pdf

architectures in networked environments:

“The great success of the Internet generally, and peer-production processes in particular, has been the adoption of technical and organizational architectures that have allowed them to pool such diverse efforts effectively. The core characteristics underlying the success of these enterprises are their modularity and their capacity to integrate many fine-grained contributions.”²³⁷

Electricity digitalisation promotes modularity, fine granularity and peer-to-peer processes – sharing not only “production” (i.e., electricity generation), but also other resources such as storage and demand management. Electricity digitalisation enables the establishment of new types of energy transactions and mechanisms for sharing energy resources, requiring the adoption of suitable “technical and organizational architectures”, mainly at local level. However, exploiting the innovative potential of electricity digitalisation also requires the existence of a suitable electricity infrastructure which is still lacking in the EU.

As already indicated in the Introduction and further elaborated in Part III of this report, energy system integration, the cornerstone of the current energy transition, requires a substantial expansion and restructuring of local electricity distribution networks, transforming them from passive elements into integrative and transformative platforms. Delays in the necessary transformation of electricity networks in general, and distribution networks in particular, represent a tragic barrier to energy decarbonisation through clean and innovative technical solutions, supported by digitalisation and new business models.

The most common argument in favour of delaying the necessary investments in electricity networks can be classified as the *shifting target syndrome of electricity networks*, derived from the “shifting baseline syndrome of fisheries”. This concept was introduced by Daniel Pauly as follows²³⁸:

“Essentially, this syndrome has arisen because each generation of fisheries scientists accepts as a baseline the stock size and species composition that occurred at the beginning of their careers, and uses this to evaluate changes. When the next generation starts its career, the stocks have further declined, but it is the stocks at that time that serve as a new baseline. The result obviously is a gradual shift of the baseline, a gradual accommodation of the creeping disappearance of resource species, and inappropriate reference points for evaluating economic losses resulting from overfishing, or for identifying targets for rehabilitation measures.”

In electricity networks, on the contrary, economic losses result from underinvestment which slows down the energy transition. The present generation of decision-makers (network operators, regulators and policy-makers – i.e., the explicit or implicit network planners) accept as network development targets the forecasts “that occurred at the beginning of their careers”, irrespective of successive anticipatory shifts in

²³⁷ Ibid., pg. 100.

²³⁸ Daniel Pauly, *Anecdotes and the shifting baseline syndrome of fisheries*, Trends in Ecology & Evolution, Vol. 10, Issue 10, October 1995, Pg. 430.

greenhouse gas emission reduction targets; they were not impressed by the expected consequences of the 2020 targets and seem equally unimpressed by the 2030 targets, with or without the Green Deal. Each time emission reduction targets are anticipated, they ignore them and stick to the old normal; they simply do not calculate the economic and environmental losses resulting from delays in developing network capacity in relation to newly set emission reduction targets. Fisheries scientists suffer from generational amnesia towards the past, network planners suffer from generational amnesia towards the future; both see the present as the only healthy scenario, and both are responsible for potentially devastating environmental consequences.

Collaboration is crucial, not only to ensure the reliability and stability of electricity systems and to enable full electricity digitalisation, as previously explained, but also to define the massive investment programmes and governance models required by energy system integration. In this sense, not only abstract, high-level electricity system attributes such as reliability are a common good, but also the very basic electricity infrastructure becomes a kind of common good that can only be efficiently shaped and managed through collaborative action.

Considering electricity networks as passive, stable, neutral, regulated, natural monopolies, instead of active, fast-growing, social platforms with a pivotal role to play in energy decarbonisation, is the origin of the tragedy of the missing commons.

19. CITIES AND ELECTRICITY

Cities are an essential feature of European history²³⁹ and the evolution of buildings and urban planning in European cities must be seen not only in a social, political, economic and cultural context, but also in relation to technical evolution and energy supply structures.

With regard to buildings, it is important to stress that nowadays “[b]oth the ethical avant-garde and the mainstream commercial architecture practices devote real attention and design ingenuity to reducing aspects of their buildings’ energy hunger, and seek external environmental assessment to corroborate their claims. (...) Yet mainstream practice around most of the world remains stubbornly dependent on heavy fossil fuel inputs. The carbon emissions of construction and buildings have risen around 1 per cent every year for the past decade.”²⁴⁰

“At present, about 35% of the EU’s buildings are over 50 years old and almost 75% of the building stock is energy inefficient. At the same time, only about 1% of the building stock is renovated each year.”²⁴¹ To improve the energy performance of buildings, a legislative framework has been put in place, including the Energy Performance of Buildings Directive 2010/31/EU and the Energy Efficiency Directive 2012/27/EU, both of which have been amended (in 2018 and 2019, respectively) as part of the “Clean energy for all Europeans” package. According to the Energy Performance of Buildings Directive, all new public buildings from 2019 and all new buildings from 2021 must be Nearly Zero-Energy Buildings (NZEB). Following the launch in 2020 of the strategy “A Renovation Wave for Europe – Greening our buildings, creating jobs, improving lives”²⁴² to boost renovation in the EU, the European Commission proposed, in December 2021, a recast of the Energy Performance of Buildings Directive²⁴³ (still in the legislative circuit).

As far as urban planning is concerned, it should be noted that “[a]ll attempts to conceptualise and design the city as a technical apparatus have, tellingly, never made it off the page. (...) The city in fact has a long history of resisting the intrusion of technology.”²⁴⁴ “Technology is indispensable: it is a prerequisite for a modern, well-functioning city. But the city should be arranged and designed in a way that shapes a world of people, not of technology. After all, it is the people who must feel at home in the city and live in it a productive and pleasant life.”²⁴⁵

239 Lorenzo Benevolo, *La città nella storia d’Europa*, Editori Laterza, 1993.

240 Barnabas Calder, *Architecture. From prehistory to climate emergency*, Pelican Books, 2021. Pg. 416.

241 European Commission, https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en

242 European Commission, https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/renovation-wave_en

243 European Commission, COM(2021) 802 final of 15.12.2021.

244 Vittorio Magnago Lampugnani, *A radical normal. Propositions for the architecture of the city*, DOM Publishers, Berlin, 2021. Pg. 27.

245 Ibid., pg. 29.

Cities were the birthplace of the electricity industry, in the 19th century. Urban density and specific urban needs (such as street lighting and affordable public transport) were decisive preconditions for the transformation of a new set of technical objects (electric generators, transformers, switchgear, light bulbs, electric motors, etc.), combined with old technical objects (namely steam generators and steam turbines), into new technical setups and business models, thus giving rise to a whole new industry. Subsequently, electrification became an essential precondition for the transformation of the old “bourgeois modernity” into a new “industrial or organized modernity”²⁴⁶, enabling new approaches to urban planning and the emergence of a new urban way-of-life, which also left indelible signs in the urban landscape²⁴⁷. In short, the city of the 19th century shaped the electricity industry, and electricity shaped the cities of the 20th century.

The present energy transition unfolds on many stages, from remote offshore areas to large industrial districts, but cities are the main stage. Cities need to transform old, passive electricity distribution networks into new platforms capable of managing Digital, Distributed, Integrated Energy Systems (DDIES). Municipalities have a crucial role to play in creating and enforcing appropriate legal frameworks that facilitate both the necessary investments and the required planning and operational governance of DDIES. Driven by ambitious climate and energy policies, 21st century cities are transforming themselves – and reshaping the electricity industry.

Decentralisation of energy resources is happening because technical and economic conditions have changed, making electricity decentralisation either inevitable (e.g., electric vehicles), financially more attractive than centralised resources (e.g., rooftop solar) or simply more appealing to those citizens and undertakings concerned about carbon footprint or energy supply resilience and ‘sovereignty’. Decentralisation does not mean reverting to some arcane relic, in the manner of Napoleon of Notting Hill²⁴⁸; on the contrary, it means applying new available technical solutions to enable a more “productive and pleasant life”.

From a public policy point of view, three different reactions to the phenomenon of decentralisation of energy resources can be observed: ignoring (‘no action’), attempting to bring it under the umbrella of the current centralised electricity system (‘taming’) or supporting its expansion under certain restrictions (‘shaping’). These three alternatives are briefly discussed below:

246 Andreas Reckwitz, *Gesellschaftstheorie als Werkzeug*, in Andreas Reckwitz and Hartmut Rosa (eds.), *Spätmoderne in der Krise*, Suhrkamp, Berlin, 2021. Pg. 99.

247 Initially, electricity replaced gas, providing stable street lighting. Gas – and oil candles before – flicker, delivering what Heinrich Heine described as a “cheeky hellfire” (*das freche Höllenfeuer*). The evolution of energy sources and associated technical devices also impacted the esthetics of light poles, which sometimes were reused and other times replaced, when moving from one source of energy to another. See Vittorio Magnago Lampugnani, *Bedeutsame Belanglosigkeiten*, Verlag Klaus Wagenbach, Berlin, 2019. Pg. 111 ff.

248 G.K. Chesterton, *The Napoleon of Notting Hill*, 1904. In his first novel, written in 1904 and set in 1984, Chesterton describes how the new King of England decides to amuse himself through “The Great Proclamation of the Charter of the Free Cities”, reestablishing Middle Ages traditions “with the fullest pomp of trumpets, plumes, and halberds”. All mayors but one politely decline the King’s invitation; the mayor of Notting Hill, a lunatic, does not realize the King’s irony and sets up a city guard, engaging on street fighting, including the remarkable “Battle of the Lamps”...

1. No action

Many psychological and sociological factors could explain this behaviour. Fortunately, this phase is over in most countries.

2. Taming

Some policymakers believe that centralised electricity markets are more efficient than decentralised markets, and therefore the bigger the centralised market the better. Consequently, decentralised electricity markets should not exist and 200 million EU households, millions of electric vehicles and small and large industries, should only be allowed to participate in the single European electricity market. There are several flaws in this reasoning:

- First of all, it is not proven (theoretically or empirically) that market efficiency would always increase in proportion to the number of market agents – there are good reasons to believe that the complexity and costs associated with aggregation and other types of transactional requirements set practical and economic limits to this “linear optimism”.
- Second, the optimality of a single European electricity market is seriously challenged by the existence of massive network shortfalls. The existence of so many network bottlenecks and associated congestion problems, leading to both structural and intermittent market splitting into multiple “zones”, creates a *de facto* fragmented reality that is at odds with the ideal conceptual single market.
- Last but not least, decentralisation and digitalisation of energy resources are “generators of diversity”. This means that they create new combinations of both supply and demand resources and this potential diversity is not and cannot be fully present in a single electricity market for two reasons: first, because many of these combinations do not yet exist, they will be invented as soon as regulatory barriers are relaxed or removed; second, because different cities will generate different types of diversity.

The project of ‘taming’ decentralisation is based on the assumption that electricity uses and users (consumers, prosumers, etc.) can be easily categorised into a small set of individual ‘products’, all of which tradable – and exclusively traded – in the centralised wholesale single market. This view ignores the reality of cities, as expressed in a well-known best-seller from 1961: “[t]o understand cities, we have to deal outright with combinations or mixtures of uses, not separate uses, as the essential phenomena. (...) So the first question (...) about planning cities is this: How can cities generate enough mixture among uses – enough diversity – throughout enough of their territories, to sustain their own civilization?”²⁴⁹

The ‘taming’ of energy decentralisation is an attempt to switch off the “generators of diversity”, inhibiting the development of new types of local bonds and imprinting on local communities a single electricity trading model – a single, technocratic “civilization”...

249 Jane Jacobs, *The death and life of great American cities*, 50th anniversary edition, Modern Library, NY, 2011. Pg. 188.

3. Shaping

Municipal autonomy was highly valued in the Italian City-States and in the German Free-Cities, but it was not until the 19th century that city management became a major political and administrative issue across Europe. City management means more than just urban planning - drawing streets, squares and public gardens *à la* Haussmann. It means providing a wide spectrum of public services²⁵⁰, including street lighting.

Municipalities across Europe have taken different approaches to street lighting, sometimes providing the service directly, sometimes through a concession to a private company, and sometimes simply imposing an obligation upon the owners of urban buildings to illuminate the road. The history of municipal management of gas and electricity supply in general, and lighting in particular, in the 19th and early 20th centuries offers valuable lessons about civic creativity and the political and cultural differences among European cities. These lessons are useful in designing the new local platforms that will shape the transition towards carbon neutrality. Some cities and metropolitan areas, in Europe and around the world, aspire to lead this process.

Urban density enabled the development of the electricity industry, in the late 19th century, and it facilitates energy system integration in the early 21st century. Despite several proclamations of the “death of the city”, the number of people living in urban areas keeps growing, having reached 56.48 % of world population in 2021, up from 55.63 % in 2019 (and 46 % in 2000)²⁵¹. Urban density can be a problem if not properly managed (“Policies on spatial distribution and urbanization are essential for achieving inclusive and sustainable development”²⁵²) but it also brings benefits: “it would be a lot better for the planet if their urbanized population lives in dense cities around the elevator, rather than in sprawling areas built around the car.”²⁵³

One of the major problems in big cities is congestion – not only in traffic, but in all types of supply²⁵⁴. Reducing excessive density may be one solution to congestion problems, “[b]ut it is not enough to reduce density, because for example Los Angeles, with an average concentration higher than New York, is strangled by car traffic, while the metropolis on the Atlantic has partially solved the problem - despite its high density - with a network of public transport efficient and constantly modernised.”²⁵⁵ The growing demand for electricity demand at local level, mainly due to the electrification of urban mobility and buildings, inevitably increases the congestion within existing electricity distribution networks. As with traffic, the expansion of an “efficient and constantly modernised” network is essential to overcome electricity congestion

250 See Ch. 5 (Construction of the modern city) in Friedrich Lenger, *Metropolen der Moderne*, C.H.Beck, Munich, 2nd ed., 2014.

251 World Bank, <https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS>

252 United Nations, *Population Facts*, December 2020, No. 2020/2. https://www.un.org/development/desa/pd/sites/www.un.org/development/desa/pd/files/undes_pd_2020_popfacts_urbanization_policies.pdf

253 Edward Glaeser, *Triumph of the city*, The Penguin Press, NY, 2011. Pg. 197.

254 Lewis Mumford, *The city in history*, A Harvest Book, 1961. Ch. 17, Section 7.

255 Cesare De Seta, *La città*, Rizzoli, 2017. Pg. 142 (own translation).

problems. However, different cities have different network expansion needs, reflecting different available energy resources, climatic conditions, societal preferences and public policies.

The difficulty of articulating universal ambitions and local efficiency is not new, as illustrated by the following statement:

“Rome did not achieve a firm and stable constitution during the Middle Ages. The great problems of general western constitutional life, which are concentrated here, and the rivalry dispute between the universal and local authorities which arose from this, acted as an obstacle to a healthy municipal constitution. (...) Of the powers that struggled for control of the Eternal City - emperor and pope, nobility and citizenry - the papacy finally claimed the place at the end of the Middle Ages; however, not as the world-ruling power that it had been in the 13th century, but rather as the head of a small princely state”²⁵⁶.

Since the 1950s, no one in Europe has aspired to “universal authority”, but “constitutional life” in Brussels is as flamboyant as it was in medieval Rome. What is at stake nowadays is primarily the establishment of a sensible and dynamic balance of power between the European Union and its Member States; however, due to demographic²⁵⁷ and social factors, municipalities play an increasingly important political, economic and cultural role in Europe. Achieving the EU’s carbon-neutrality targets is impossible without a “healthy municipal constitution”, which means redesigning the EU’s multi-layered institutional architecture in the spirit of subsidiarity and solidarity, reinforcing the role of municipalities and inter-municipal associations. Governance of the EU’s multi-layered and multi-sectoral energy markets can only be effectively implemented within such a renewed EU institutional framework.

Modern information and communication techniques have blurred the traditional boundaries between city and home. So-called social media (i.e., Internet-based applications managed by large companies which organise user networks that enable the production and circulation of user-generated content²⁵⁸) and Covid lockdowns have brought the home to the forefront of social and economic life, establishing a direct link between the home and the entire planet, thus transcending the city. This evolution has obvious political and philosophical implications²⁵⁹; however, managing the generation and use of electricity requires physical networks, and these impose not only physical constraints but also a material interconnectedness that cannot be overlooked. A person living in Brussels can exchange data with a person living in New York but cannot send excess solar electricity generation from her or his rooftop across the Atlantic; on the other hand, this electricity can easily be shared in the neighbourhood.

256 Otto Hintze, *Storia costituzionale e amministrativa degli Stati moderni: l'Italia medievale e moderna*, Viella, Roma, 2022. Pg. 170 (own translation).

257 Between 1960 and 2021, urban population in the EU increased from 209 to 336 million, representing, respectively, 59% and 75% of total population. <https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=EU>

258 Connecting 4.8 bn people (59% of world population), as of January 2023 <https://datareportal.com/social-media-users>

259 See Emanuele Coccia, *Filosofia della Casa*, Einaudi, Turin, 2021.

20. REVISITING THE INTERNAL ELECTRICITY MARKET – IDENTIFYING REFORM AREAS AND REFORMERS

“Sabotage commonly works within the law, although it may often be within the letter rather than the spirit of the law. It is used to secure some special advantage or preference, usually of a businesslike sort.”

Thorstein Veblen ²⁶⁰

Thorstein Veblen (1857-1929) was one of the most original and innovative economists and sociologists; among other things, he coined the expression “conspicuous consumption”, back in 1899, and studied how institutions determine the use of technologies – a very useful contribution to better understanding the current energy transition. His analysis of sabotage in the industrial age is also quite entertaining, as revealed by the above-mentioned quote. As recent months have shown, electricity market reform is definitely an area where sabotage is at work, “within the letter rather than the spirit of the law”.

The current debate on EU electricity market reform was triggered by the President of the European Commission in June 2022²⁶¹ and has since been supported by the European Parliament, several Member States and many private organisations. However, it has also been openly criticised by some - and in some cases actively resisted (sabotage...). Opposition to the very idea of market reform in general can be divided into two groups:

- A) Deniers** - believe that the current EU electricity market works very well and is well adapted to EU public policies - i.e., there is no need for market reform. While some deniers simply “see” no strong reason for change in the present, without denying the possibility of a need for reform in the future, others are plain blind ideologues convinced that the current model cannot be improved at all.

Pretending that a theory - in this case, an economic theory - cannot be improved upon, and therefore has perennial validity, is a primary anti-scientific position; pretending that a real market - in this case, an electricity market – can and should be regarded as the automatic application of pure theory, without undergoing social mediation, is another basic anti-scientific and ahistorical position. Like vested interests, deniers should be recognised, but rebuttal of their positions is straightforward.

²⁶⁰ Thorstein Veblen, *The engineers and the price system* (1921), in *The collected short works of Thorstein Veblen*, vol. I, Vernon Press, Delaware, 2014. Pg. 46.

²⁶¹ Speaking on the 7th of June 2022 at the European Parliament Mrs. Von der Leyen stated that “this market system does not work anymore. We have to reform it. We have to adapt it to the new realities of dominant renewables. This is the task that the Commission has taken over now. This is not trivial. This is a huge reform. It will take time. It has to be well thought through. But we need to step forward to adapt our electricity market to the modern conditions.” In her speech on the State of the Union, on the 14th of September 2022, she delivered a similar message: “The current electricity market design – based on merit order – is not doing justice to consumers anymore. They should reap the benefits of low-cost renewables. So, we have to decouple the dominant influence of gas on the price of electricity. This is why we will do a deep and comprehensive reform of the electricity market. (...) Not just a quick fix, but a change of paradigm, a leap into the future.”

Indeed, deniers are active in many policy fields, namely in climate policy, and behave in a similar way:

“No one wants to admit to being duped by disinformation or blinded by a myth, and people in positions of privilege rarely examine the basis for that privilege. Perhaps, most deeply, the climate crisis breaks the promise of progress. And so, even today, many people who are not necessarily climate-change ‘deniers’ resist meaningful action, refuse to acknowledge just how broken our economic systems are, and deny how much damage industry disinformation has done.”²⁶²

B) Fearful - accept that some improvements could be made, but fear that public debate and political negotiation, rather than enabling such improvements, could lead to a worse situation than the current one. In particular, they fear that reform could lead to (or both of) the following outcomes: 1) more State intervention and less market freedom; 2) more national and less EU market transactions and political decisions. In other words, they fear that both energy liberalisation and EU energy integration could go backwards.

Analysing these perceived risks is worthwhile because it reveals several misunderstandings and ambiguities that have conditioned the construction of the European electricity market in the past and are now blocking its future evolution. It helps to identify technical and non-technical issues that urgently need to be reassessed.

State and market

Over the last 15 years, the presence of the State has been particularly visible in so-called Western democracies (in autocratic regimes the State is indeed the dominant and exclusive presence in the public space, often invading and attempting to control the private sphere):

- In 2022, State intervention was activated to support Ukraine, both economically and militarily, for the sake of European security.
- In 2020, States around the world intervened in various ways, including through massive subsidies, to produce vaccines and control the impact of Covid upon public health and society at large.
- In 2009/2014, the European Union struggled to overcome the sovereign debt crisis. In September 2012, the European Central Bank announced free unlimited support for all eurozone countries (“*whatever it takes*”), calming financial markets.
- In 2007/2008, the United States of America managed the global financial crisis by acting as a *de facto* central bank for many countries around the world, even if the Bretton Woods monetary system had been abolished in the 1970s.

²⁶² Naomi Oreskes, *Why didn't they act?*, in Greta Thunberg (ed.), *The climate book*, Allen Lane, 2022.

All these recent State interventions for the sake of public interest (financial stability, economic growth, public health, security, etc.) have increased public debt and had massive distributional effects, both between and within countries. As all the crisis that triggered these State interventions emerged unexpectedly and spread hastily, thus requiring rapid action, there was little debate before action was taken. In particular, the definition of the “public interest”, the role of different actors and the role of the State in crisis management were not seriously debated (except by radical anti-statist movements, which oppose any State intervention as a matter of principle).

Central banks played a key role in crisis management and continue to play a crucial political role in managing financial flows and inflation, although their policies and their actions are usually qualified as “technical” and non-political. In a recent book analysing the current monetary system, Stefan Eich provides a brilliant reconstruction of past monetary proposals, from Aristoteles to the present day, showing how different political assumptions and values have been projected onto the politics of money. Having shown how money has been politicised in different ways in the past, he logically concludes that the current debate “cannot be over *whether* money has or should have a political dimension but instead over *how* that politics ought to play out and what values should guide it.”²⁶³ Analysing the role of central banks in recent years, some authors believe that they became the very engine of capitalism²⁶⁴.

The discussion about how to establish a more explicit, transparent, and democratic relationship between state and market in our contemporary global world goes beyond monetary policy; it includes energy and other sectors, because the existing models were developed within the same cultural and political environment:

“It was a specific *politics* of depoliticization that instituted policies designed to give the appearance of a spontaneous, depoliticized economic realm and that ended up heavily curtailing the ability of states to intervene in economic relations. (...)

But if the ability of the state to interfere with economic matters was never in question, what social and political theorists - such as Bell, Habermas, and Walzer - underestimated was the ease with which democratic states willingly abandoned their responsibilities in the economic realm. Rather than being politically punished for having to make difficult distributive choices, politicians much rather pretended to be powerless.”²⁶⁵

First the pandemic, and now the war in Ukraine, have shown how important politics is - and how powerful politicians can be vis-à-vis the markets.

Political action is needed now, not only to restore democratic legitimacy by establishing a healthy control of financial markets by democratic bodies, reversing the past trend of financial markets capturing politics and the State, as Stefan Eich and others have pointed out, but also to promote sound, sustainable economic development. This need was particularly well illustrated in a recent book by Jacques de Larosière, former head of IMF, EBRD and the French central bank:

²⁶³ Stefan Eich, *The currency of politics*, Princeton University Press, 2022. Pg. xvi.

²⁶⁴ Joscha Wullweber, *Zentralbankkapitalismus*, Suhrkamp Verlag, Berlin, 2021.

²⁶⁵ Stefan Eich, *The currency of politics*, Princeton University Press, 2022. Pg. 202.

“It is above all necessary to understand how our world has surreptitiously changed its model: it has slipped, for two decades, towards a strange paradigm, one where most economic activity is now reflected in the rise in the valuations of financial assets to the detriment growth in wage income and productive investment. (...)”

We have come to a point where what should be complementary – i.e., borrowing beyond self-financing – has become the norm, and where financial fiction dominates economic reality.”²⁶⁶

De Larosière concludes that “[t]oday’s financial market configuration cannot, in any way, be the foundation and the guide for future action and policy. (...) We must get out of a model that favours illusion over reality.”²⁶⁷

Financialisation, i.e., the increasing importance of financial markets and financial institutions in economic and political life, is exacerbated by their association with electronic networks, enabling the creation of a global “market of all markets” where “information about money became more important than money itself”²⁶⁸.

The increasing control of economics over politics is also well illustrated by “how economists invented austerity”²⁶⁹. The capture included legal theory: “It is increasingly obvious that many questions that twentieth-century liberals had characterized as technocratic economic matters are instead fundamentally political questions. (...) In other words, they are questions of constitutional political economy. But the current conventions of constitutional discourse largely conceal their constitutional dimensions.”²⁷⁰

Recognising that electricity decarbonisation and electricity digitalisation require appropriate policies, not only to trigger and to sustain each of these processes, but also to promote the convergence of the two and to manage overarching issues (such as security), does not mean that there is no place for competition and for organised markets in electricity sector. It simply means that electricity markets must evolve in line with the evolution of societal needs, which are translated into policy inputs that impact not only regulative rules, but also the constitutive rules of the markets. In other words, electricity markets are not autopoietic systems, i.e., they have never been and they are not self-organising systems.

266 Jacques de Larosière, *En finir avec le règne de l’illusion financière. Pour une croissance réelle*, Odile Jacob, Paris, 2022. Pgs. 8, 9.

“Il faut surtout comprendre comment notre monde a changé subrepticement de modèle: il a glissé, depuis deux décennies, vers un paradigme étrange, celui où l’essentiel de l’activité économique se traduit désormais par la hausse des valorisations d’actifs financiers au détriment de la croissance des revenus salariaux et de l’investissement productif. (...)”

Nous sommes arrivés à un point où ce qui devrait être un complément - c’est-à-dire le recours à l’emprunt au-delà de l’autofinancement - est devenu la norme, et où la fiction financière domine la réalité économique.”

267 Ibid., pgs. 120, 127.

268 Joseph Vogl, *Kapital und Ressentiment*, C.H.Beck, Munich, 2021. Pg. 49.

269 Clara E. Mattei, *The Capital order. How economists invented austerity and paved the way to fascism*, The University of Chicago Press, 2022.

270 Joseph Fishkin and William E. Forbath, *The anti-oligarchy constitution*, Harvard University Press, 2022. Pg. 28/9.

The assumption that *any* political intervention in the functioning of electricity markets automatically leads to a loss of economic efficiency is theoretically and historically as absurd as the assumption that competition cannot be applied to electricity. The kind of policy intervention needed to ensure that the 2030 and 2050 climate targets are met in the energy realm actually promotes consumer choice, freedom and competition across multiple platforms. Very often, behind paladins of the *status quo* are vested interests that truly fear competition - from other platforms, other technical solutions, other business models. Their repugnance to political intervention disguises their aversion to innovation.

About the author

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First chairman of the Portuguese Energy Regulatory Authority (1996 / 2006). Co-founder and first chairman of the Council of European Energy Regulators (2000 / 2005). First chairman of the European Regulators' Group for Electricity and Gas (2003 / 2005). Co-founder of the Ibero-American Association of Energy Regulatory Authorities (ARIAE). Founder and member of the Executive Committee of the Florence School of Regulation.

Graduation in power systems from Porto University and Dr.-Ing. degree from the University of Erlangen-Nuremberg.

My current views on energy markets and energy regulation reflect a combination of different professional involvements over the last 40 years, namely:

- 40 years of academic experience;
- 4 years in the power systems equipment industry (networks);
- 7 years with the European utilities association when liberalisation started and interconnections with Eastern Europe were established;
- 10 years' energy regulation;
- 15 years of entrepreneurial involvement with renewable energy, energy efficiency and energy digitalization;
- many years of experience advising policy makers, regulators, financial institutions and undertakings on energy topics in several countries, spread over four continents.

